The Community Aquatic Monitoring Project (CAMP) for Measuring Marine Environmental Health in Coastal Waters of the southern Gulf of St. Lawrence: 2004 Overview

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by

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ABSTRACT

During 2003, the Stewardship and Environmental Science Sections of the Department of Fisheries and Oceans (DFO) Gulf region Oceans and Science Branch collaborated in developing a monitoring program to help determine the ecological health of estuaries and coastal shorelines in the southern Gulf of St. Lawrence (sGSL).

The outcome of this initiative was the Community Aquatic Monitoring Program (CAMP). The primary goal of CAMP is to test the hypothesis that a relationship exists between the health of an estuary or coastal shoreline and the diversity and abundance of finfish and crustacean species which inhabit the littoral or near shore zone. Simply stated, an estuary which has been degraded by human activity may have fewer species or fewer individuals of certain species or more of other species than a healthy, undisturbed estuary.

Launched officially in 2004, CAMP has expanded the number of locations from 4 in its pilot year (2003), to 24 throughout the Maritime Provinces of Nova Scotia (NS), New Brunswick (NB) and Prince Edward Island (PEI). As a part of the expansion, a student was hired as a youth intern to help train and mentor non-governmental organisation (NGO) participants and to record and collate all data for all sites.

Each NGO adhered to the same sampling methodology and related protocols. Basic methodology involved monthly day-time beach-seining at 6 sites around each estuary. All species of finfish, crabs and shrimp collected were identified, enumerated, separated into young of the year and adults and then released. As well, there was coincident collection of supporting habitat information (water temperature, salinity, dissolved oxygen, cover of plants and algae and substrate grain size, moisture content and organic content).

One of the goals of the CAMP program is to provide local environmental groups with an established and uniform set of methods that will help them better understand the ecosystem dynamics of their local estuary. The NGO's will be able to use the information derived from their sampling regime to help them make more informed decisions regarding their estuary. DFO provides equipment, support and expertise for training and data analysis.

This report presents baseline physical and biological data for the estuaries sampled in 2004. In order to test the hypothesis that these data reflect environmental quality, several years of data will be required to detect temporal and spatial patterns that may exist. Ultimately it is hoped that this program will provide a simple method of characterizing estuarine health that community groups will find both useful and easy to apply.

RÉSUMÉ

En 2003, les sections de l'Intendance et des Sciences de l'environnement de la Direction des océans et des sciences, de la Région du Golfe, au Ministère des pêches et des océans (MPO), ont élaboré ensemble un programme de surveillance dans le but de déterminer l'état de santé écologique des estuaires et des rivages du sud du golfe du Saint-Laurent (sGSL).

Cette initiative a donné le Programme de surveillance de la communauté aquatique (PSCA). Le but premier du PSCA est de vérifier l'hypothèse voulant qu'il existe une relation entre la santé d'un estuaire ou d'un rivage et la diversité et l'abondance des espèces de poissons et de crustacés qui l'habitent. Autrement dit, un estuaire qui a été endommagé par l'activité humaine compterait moins d'espèces ou moins d'individus d'une espèce en particulier qu'un estuaire sain et non perturbé.

Lancé officiellement en 2004, le PSCA a multiplié ses zones d'étude qui sont passées de quatre pendant l'année d'essai (2003) à 24. Ces zones sont réparties dans les trois provinces Maritimes, soit la Nouvelle-Écosse (N.-É.), le Nouveau-Brunswick (N.-B.) et l'Île-du-Prince-Édouard (Î.-P.-É.). Un étudiant a été embauché dans un poste de jeune stagiaire afin d'aider à former et à encadrer les participants d'organismes non gouvernementaux et à rassembler et à consigner les données pour les 24 zones d'étude.

Les ONG devaient utiliser la même méthode et les mêmes protocoles d'échantillonnage, comme suit : une fois par mois, faire un relevé de jour, par senne de rivage, à six endroits situés dans chaque estuaire. Chaque espèce de poisson, de crevette et de crabe prélevée était énumérée, identifiée, triée selon l'âge (groupe des jeunes de l'année et groupe des plus âgés) puis remis à l'eau. On a également recueilli des données sur les habitats de ces espèces, par exemple la température de l'eau, la salinité, la teneur en oxygène dissous, la superficie recouverte par les plantes et les algues, le calibre du grain du substrat, la teneur en eau et la teneur en matières organiques.

Un des objectifs visés par le PSCA est de fournir aux groupes environnementalistes locaux une série d'outils susceptibles de les aider à mieux comprendre la dynamique de l'écosystème de leur estuaire local. Les ONG pourront utiliser l'information découlant de leur plan d'échantillonnage afin de les aider à prendre des décisions informées quant à leur estuaire. Le MPO quant à lui offre du matériel, du soutien et des compétences spécialisées pour la formation et l'analyse des données.

Le présent rapport fournit des données de référence provisoires sur les caractéristiques physiques et biologiques des estuaires qui ont fait l'objet de relevés en 2004. Avant de pouvoir valider l'hypothèse selon laquelle ces données reflètent réellement l'état environnemental des estuaires, il faudra encore plusieurs années d'échantillonnage en vue de cerner tout profil temporel et spatial éventuel. En bout de ligne, nous espérons que ce programme offrira une méthode de caractérisation de l'état de santé des estuaires que les groupes locaux trouveront à la fois utile et facile à appliquer.

1.0 INTRODUCTION

1.1 Background

In the Canada Oceans Strategy document (COS, 2002), Fisheries and Oceans Canada (DFO) established its commitment to work collaboratively with local stakeholders to "*establish marine environmental quality guidelines, objectives and criteria respecting estuaries, coastal waters and marine waters.*" During 2003, the Stewardship and Environmental Science Sections of DFO Gulf Region integrated their planning priorities to develop a practical monitoring program that would assist in determining the ecological health of estuaries in the southern Gulf of St. Lawrence (sGSL). The outcome was the development of the Community Aquatic Monitoring Program (CAMP). One of the aims of the program is to determine if a relationship exists between the health of an estuary and/or a coastal shoreline and the diversity and abundance of conspicuous invertebrate and fish species which utilize this ecosystem. The hypothesis being tested by CAMP is that an estuary which has been degraded by human activity may have fewer species and different abundance of individuals than a healthy, undisturbed estuary.

Estuaries and coastal shoreline locations can have the following variations. Some sampling locations were totally along the estuary. Coastal shoreline sample locations may have minimal estuarine input such as around a bay. Other sample locations can have estuarine habitats upstream and at the mouth have sites with shoreline characteristics.

Launched in the summer of 2003, CAMP was piloted and developed at four locations within the sGSL - Lamèque Bay and Shediac Bay estuary in New Brunswick, Antigonish Harbour in Nova Scotia, and Basin Head in Prince Edward Island. The two locations within New Brunswick were chosen mainly because they have seafood processing plants that may be affecting the local environment. Antigonish Harbour was chosen because of potential agricultural impacts from upstream which may affect fish species and habitat in the estuary. Basin Head was chosen because at the time, it was an Area of Interest in the Marine Protected Areas Program of *Canada's Oceans Act*; it is now a Marine Protected Area (MPA).

Methods and protocols to implement the CAMP approach were chosen after reviewing a wide variety of methods for evaluating estuarine health (Bortone, 2005). Bortone et al. (2005) describe fish as estuarine health indicators for US sites using procedures similar to those used by CAMP personnel. Two studies by Lekve et al. (2002) examined relationships related to species richness of fish populations in coastal areas. One study demonstrated that abiotic variables of salinity, temperature and dissolved oxygen were linked to coastal community structure of fish populations. This provided the basis for including measurement of these physical parameters in the CAMP protocol.

The 2004 field season expanded the CAMP program in all three provinces. This report will provide an overview of the CAMP project, and discuss some of the results and outcomes of the 2004 field season.

1.2 Stewardship –What is it? Who is involved?

Stewardship is the involvement of citizens acting responsibly toward the environment (Canada's Stewardship Agenda. 2003). Stewardship is the responsible use of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as of private needs, and accepts significant accountability to society (Worrell and Appleby, 1999).

Although there are many definitions of stewardship, most encompass the following concepts and principles;

- The concept of sustainability, living within earth's limits.
- Adopting ecological principles and ecosystem approaches - viewing the environment in a holistic manner.
- Partnerships involving local capacity and ownership - community involvement.
- Respect for the environment, the interests of others and the rights of all participants.

1.3 Canada's Stewardship Agenda

Canada's Stewardship Agenda involves applying the concepts and principles listed above not only to projects like CAMP, designed with these principles in mind, but to our personal everyday activities. We all share and depend upon the same resources, water, air, soil, so we all have a stake in our environment. What happens locally can have global repercussions which can translate into a variety of affects on other communities. The importance of local environmental groups taking ownership of a section of their local ecosystem, such as their community estuary, cannot be understated. They become the most effective stewards because of their proximity and local knowledge. The support they receive from government agencies becomes part of the integrated management plan for that system. Working together, all groups have the advantage of using the knowledge base available to most effectively manage the estuary for which they have become stewards.

1.4 What is CAMP? Where is CAMP done? Who is involved?

CAMP is a long term community aquatic monitoring program used to determine the ecological health of estuaries and coastal shorelines in the sGSL region. It was determined through consultations with DFO Environmental Science and Stewardship sections that to become a baseline location, an estuary or coastal shoreline would be sampled monthly during the summer months (5X) at 6 chosen stations. This resulted in establishing nine sample estuaries in NB, three sample estuaries in NS and three sample estuaries in PEI, as illustrated on the map below. Masters' student, Marie-Hélène Theriault, working through DFO and Université de Moncton (U de M), sampled 3 of the 9 NB baseline estuary locations as part of her research related to community composition and effluent discharge. Other estuaries throughout the three Maritime Provinces were sampled for portions of the season and were not considered as full baseline locations for comparative analysis. Groups working at many of these locations plan to implement a full sampling regime in 2005.

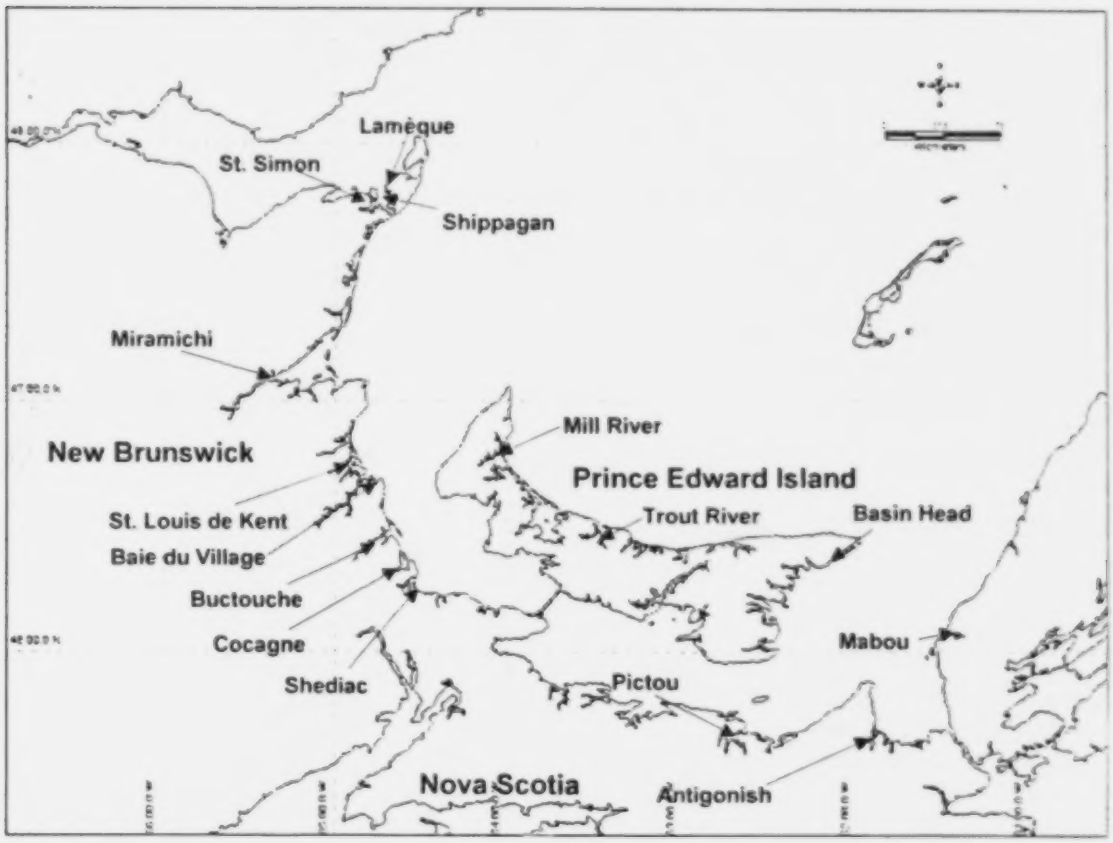

Figure 1. CAMP baseline monitoring locations for NB, NS and PEI. Each arrow shows the location of a baseline sampling estuary that includes six sample stations.

The CAMP program involves several partnerships including DFO Oceans and Habitat Division, DFO Aquatic Health Division, universities, various environmental organizations and local estuary watershed conservation groups, all based throughout the Gulf Region. For example, the following groups, representing NB, PEI and NS respectively, have been involved with CAMP in 2004. Some have engaged in a full baseline sampling commitment and others have done limited sampling.

<u>New Brunswick</u>

- Miramichi River Environmental Assessment Committee
- Friends of the Kouchibouguacis River
- Southeastern Anglers Association
- Pays de Cocagne Sustainable Development Group
- Shediac Bay Watershed Association

- Coalition pour la viabilité de l'environnement des havres de Shippagan et les Îles Miscou et Lamèque
- Partenariat pour la gestion intégrée du bassin versant de la baie de Caraquet
- Tabusintac Watershed Association
- Comité sauvons nos rivières de Neguac
- Richibucto River Association
- Students from the University of Moncton Biology Department

Prince Edward Island

- Mill River Watershed Improvement Committee
- Basin Head Lagoon Ecosystem Conservation Committee
- Trout River Environmental Committee
- Southeast Environmental Association
- Winter River Environmental Committee
- Montague Watershed Improvement Committee
- Students from the University of Prince Edward Island Biology Department

Nova Scotia

- Mabou Harbour Coastal Management Planning Committee
- Pictou County Rivers Association
- Pictou Harbour Environmental Protection Project
- Friends of the Pugwash Estuary
- Fresh Air Outdoor Adventure Society-Antigonish
- Students from the St. Francis Xavier University Biology Department and program in Integrated Studies in Aquatic Resources (ISAR).

Participation of community groups is a fundamental component of the CAMP program, as communities share the responsibility of volunteering their time to monitor estuaries and coastal shorelines in their area. As they often have several projects related to the estuary, their work is instrumental in demonstrating and initiating correct stewardship principles.

1.5 What is an estuary? Why are estuaries important? Why monitor estuaries?

An estuary is a complex coastal ecosystem that is open to the sea at one end, semi-enclosed through-out the length and receives an input of fresh water (Bortone, 2005). It is also a transitional area between marine and freshwater biomes, typically having large fluctuations of salinity associated with inflows of fresh water from the nearby land (Freedman, 2004). In contrast to other transitional areas, estuaries have a limited number of permanent biota

because of the physical and chemical characteristics of this habitat. Estuaries are considered among the most productive ecosystems on the planet even though few of the many different species of plants and animals are permanent residents (DFO, By the Sea, 1996). Estuaries provide important habitats for juvenile stages of many species of fish, shellfish and crustaceans and therefore have an important role as a nursery (Freedman, 2004).

Estuaries in the sGSL have major environmental, economic and social importance. They reflect the state of the environment of their surrounding watershed, and they have a major influence on the production of adjacent marine systems. Although current levels of development in the region have meant that estuaries are not in the same state they were several decades ago, they still provide largely intact biological communities. These communities appear to have maintained a certain level of biological composition, while simultaneously being exposed to commercial and recreational disturbances. The surrounding catchments have been utilized for a wide range of human activities including farming, forestry, increased urbanization and localized industrial development. While these human activities have had major local effects, estuaries and coastal shorelines in the region are still biological systems that continue to function. Estuaries and coastal settlements are inextricably linked. Thus, what happens in the estuary effects both the natural and human environment, and vice versa. This concept was examined in 2003 using a Mya-Macoma health index approach in northern Gulf estuaries by researchers from DFO Mont-Joli; Mark, Provencher and Munro (2003). This report develops a framework for monitoring and assessing marine ecosystem health at the level of biological communities (clam species) in the littoral zone.

Retaining and possibly improving current levels of biological integrity requires vigilance at the local level. It requires qualified observers who can observe and document change before the systems undergo major deterioration so that negative impacts can be prevented or at least minimized. CAMP is an important initiative that will help to determine present status of estuaries and coastal shorelines. This initial evaluation will provide part of the basis for subsequent mitigative suggestions.

1.6 Primary Objectives of CAMP

The primary objectives of CAMP are as follows:

1) To provide local environmental groups with the infrastructure and expertise to evaluate the health status of their estuaries/coastal shorelines.

2) To acquire baseline data on the present state of biological communities in estuaries/coastal shorelines in the sGSL.

3) To more clearly determine factors affecting the relationship between ecological health of estuaries/coastal shorelines and their biological communities.

4) To take note of the introduction and changing status of populations of invasive organisms and their impact on local communities.

5) To develop local expertise that can function as an early warning system for impacts on the environmental integrity of each estuary/coastal shoreline.

6) To develop protocols that can be easily applied to other systems.

7) To promote and enhance stewardship of estuaries by community groups.

8) To enhance integrated management between DFO, community groups, universities, various environmental organizations and local estuary watershed conservation groups.

2.0. MATERIALS AND METHODS

Monthly daytime sampling was done at each station from May to September 2004 inclusive. Data on invertebrates and fish species, macrophytes, water quality and benthic substrate were collected at 90 sampling stations throughout the provinces of NB, NS and PEI. Various methods were used to collect and monitor the presence and abundance of estuarine species and to collect specific environmental data from each station. This included beach seining, use of a quadrat for vegetation coverage, meter readings to record temperature, salinity and dissolved oxygen and substrate collection. These are described ion more detail below.

2.1 Training

The training program for CAMP is a combination of theory and practical sessions.

The theory session includes an hour long presentation on CAMP which includes a background of the CAMP program, an outline of the methodology, an introduction to the equipment, training on use of the field data collection sheets and an identification review to the species sampled during the field season.

The practical training involves learning the proper use of equipment, sample techniques and identification of fish, crustaceans and plant species. This involved an on-site actual beach seine collection at specific pre-determined CAMP sampling stations. After the beach seine, trainees were shown the characteristics used to properly identify each invertebrate and fish species collected. The volunteers would then identify the contents of the beach seine while DFO trainers assisted with verification and review.

A fundamental aspect of the sampling is that it is non-destructive, with animals being returned unharmed to their habitat.

2.2 Site Selection

The selection of estuary/coastal shoreline sample sites throughout the sGSL was based on the interest from community organizations as well as input from DFO's Area Offices and Regional Headquarters.

Some of the criteria considered in choosing a sample station within an estuary/coastal shoreline would include the following:

- Presence or past occurrence of some degree of vegetation (primarily looking for eelgrass *Zostera marina).*
- Convenient access to the shore or at least in close proximity to facilitate access to the station.

- Stations need to be as comparable to one another i.e. salinity, temperature, depth, bottom type and vegetation were to be as similar to each other as possible.
- Include the 6 sampling stations to incorporate as much of the entire estuary as possible; the basic criteria was to choose an upper, middle and lower estuary station.
- Attempt to get 3 sampling stations on each side of the estuary, or in the case of a coastal shoreline location, choose sites around the bay or up and down shore from any small estuary input.

2.3 Beach Seining

A 30 x 2 m beach seine, with a 6 mm mesh size and a central bag measuring 2 x 1 m, was used to sample both demersal and pelagic fish, invertebrates and crustacean species in the littoral zone. A typical beach seine has a float line to keep the edge on the water surface and a lead line to keep the other edge on the bottom. (see **Figure 7** in **Appendix 1**, for more details describing a beach seine).

Seining was done from the shoreline at each sample station, and encompassed an area of approximately 225 m^2 for each net haul. The seine was walked out 15m perpendicular to the shore, until the bag was in the water. This left 15 m of net on shore. At this point the net hauler turned parallel to the shore and walked until all of the net is in the water. At this point, the net was brought back to shore. The seine was then hauled to shore by pulling on the ends of the wings, being careful to keep the bag centered and the lead line on the bottom. Once hauled to shore the contents of the bag were carefully emptied into a live box. A live box is the same plastic bin that was used to carry the net. The bin was placed in water and holes in the bin allow water exchange so the collected specimens were kept alive during the identification, counting, recording and release process. The wings of the net laid out on shore were systematically examined for any remaining species in the net.

The invertebrates and fish species were then identified to species or genus (see section 2.5.1), separated by developmental growth stage; young of the year or adult, counted, to a maximum of 300 beyond which numbers were estimated (see section 2.4.3), noted on the field data sheet, and then released live back into the estuary.

2.4 Sampling Protocols

Previous experience has identified three areas that deal with sampling problems. These include: 1. snagging of the net; 2. plant debris such as excessive sea lettuce; 3. catches too large to count before fish mortality. More detailed protocols related to sampling procedures have been included in **Appendix 2**.

2.4.1 Net Snagging

Certain hindrances, such as a rock or piece of wood, may stop the natural movement of the net as the net is being pulled through the water column. The hauler must identify that the net is not moving normally. When this happens, another person must move along the outside of the net and locate the obstruction. With their foot or preferably their arm, they have to lift the lead line over the impedance with minimal vertical rising so that fish cannot escape.

2.4.2 Plant Debris

Later in the sampling season (summer), the detrital plant matter suspended in the water can accumulate near the shore due to current, wind and wave action. A site that was clear on one visit can change drastically a month later. The initial evaluation when choosing the site should determine, as far as possible, whether the site will remain useable through-out the season. Anecdotal information about the site is usually available from the experience of the local CAMP volunteers.

When volunteers arrive at the site to sample, the presence of excess plant debris can usually be determined because floating and suspended material such as sea lettuce (*Ulva lactuca*) can be seen.

If excessive plant debris develops as a problem later, the site should be changed. Since the net hauler is in the water they can choose a certain path that may reduce the debris collection without compromising the hauling technique integrity. Shoreline debris, such as a berm of decaying eelgrass fronds (*Zostera marina*), can be removed manually before the net is hauled in to shore. When suspended plant debris in the beach seine path is unavoidable, one method is to remove the sea lettuce with a rake or fork as the net is hauled in. Removing excessive plant matter would be necessary if the net cannot be moved due to the large mass of debris in the net. Volunteers shake the fork full of plant material inside the area of collection to retain organisms to be identified and throw the debris outside the net. The fish will remain in the collection area if the plant material is not compressed.

2.4.3 Large Numbers of Fish

At certain sites and at certain times of the year, many fish can be collected in the net sweep, sometimes in the thousands for certain species. Locations near fish plant outlets can also be the habitat of large schools of smaller pelagics such as mummichogs, sticklebacks, silversides and sand shrimp. When sampling in these locations, more fish may be caught than can be reasonably counted before more sensitive species die from crowding in the live-box. A protocol has been developed to handle these large fish numbers (**Appendix 2**). Briefly, species that will exceed 300 in number are enumerated in 5 sub-samples (20 cm square aquarium dipnets). If the number of available volunteers is not adequate, then 2 sub-samples might be all the sampler has time for. After the sub-sample has been recorded, fish are emptied from the live-box by dipnet, keeping track of how many dipnets are emptied. The numbers of any rare species present are recorded as observed. The total number of the most abundant species is then estimated as the product of the number of dipnets and the mean number of that species per dipnet, calculated from the 5 sub-samples counted. This has to be done as quickly as possible to minimize the mortalities. Organisms most susceptible to oxygen deprivation, such as juvenile smelt and silversides, should be removed first.

2.5 Identification

2.5.1 Fish and Crustaceans

Community groups were given hands-on training by various regional employees from DFO to identify features and characteristics of fish and crustacean species within their region. When difficulties with identification arose, groups could refer to the CAMP identification guide (compiled and summarized by Marie-Hélène Theriault) for clarification, or collect a specimen

for identification. The unknown species should be put on ice and frozen or preserved upon return to the NGO field station. Guides such as Peterson Atlantic Coast Fishes and Atlantic Seashore field guides were made available and distributed to community groups to be used to assist with identification. A complete list of species identified in 2004 is listed in **Appendix 3**.

For the most part identifying fish and crustacean species was easily accomplished; however, there were initial difficulties distinguishing between mummichogs (*Fundulus heteroclitus*) and banded killifish (*Fundulus diaphanus*) and winter flounder (*Pseudopleuronectes americanus*) and smooth flounder (*Pleuronectes putnami*).

F. heteroclitus and *F. diaphanus* are related species with subtle and sometimes subjective differences between their features, for example, slenderness, head shape, bar markings, and positioning of the caudal peduncle. Although, the gill rakers, are particularly useful in distinguishing between these two species (4-6 for *F. diaphanus*, and 8-12 for *F. heteroclitus*) (Scott and Scott, 1988) they can not be counted without dissecting their gills, and are therefore not suitable for CAMP live release methodology. It was also determined that a hybrid known to exist between these two *Fundulus* species (Fritz and Garside 1974) was present, further complicating identification. As a result, *F. heteroclitus* and *F. diaphanous* were grouped together as *Fundulus sp.* for data compilation and analysis because of the identification difficulties that volunteer groups encountered.

Distinquishing between juveniles of winter flounder (*Pseudopleuronectes americanus*) and smooth flounder (*Pleuronectes putnami*) was difficult at times, as there was confusion over which features were most accurate in distinguishing them. In addition, diagnostic features to distinguish them were not consistent from source to source. Consequently their numbers were grouped for data analysis. Adults of these two flounder species, however, were distinguishable and were recorded separately.

If a species was captured that could not be identified in the field, one or two specimens were frozen in a plastic bag (or other appropriate container) for later identification. If possible, a digital photograph was also taken to assist with fish identification. Additional detail regarding fish identification can be found in **Appendix 4**. The action of retaining a species for identification is allowed under the regulations outlined in the Section 52 permit. (see section 2.9)

2.5.2 Young of the Year and Adult

Young of the year (YOY) are newborns hatched this season. Many common littoral fish species spawn in summer (e.g., mummichogs, silversides, sticklebacks) but a few spawn in winter or early spring (e.g., Atlantic tomcod, smooth flounder, smelt) For the summer spawners, everything caught before mid-June can be assumed to be adult. In the summer and fall, however, there will be a mixture of adult and YOY present which become increasingly difficult to distinguish as YOY grow. Guidelines to assist with these distinctions are offered in **Appendix 4.**

A separate problem was found in distinguishing YOY of some similar species which spawn at the same time. Black spotted and 3-spine sticklebacks are both silver colored for example, and so were pooled as *Gasterosteus sp.* on the data sheet under YOY. Similarly, mummichog and killifish YOY were sometimes identified only to genus (*Fundulus*) as were YOY smooth flounder and winter flounder (Family Pleuronectidae).

2.6 Macrophytes

A 50 cm x 50 cm quadrat, divided into four equal sub-quadrats, was used to estimate macrophyte % cover at each sample station. The quadrat was thrown three times, within the sample area, and a viewing bucket (bucket with clear plexiglass bottom) was used when needed to observe and estimate the vegetation coverage (see **Appendix 1**, **Figure 9**). The data sheet was used to record the approximate percentages of the dominant plant types. The use of this quadrat method was possible only when the water column was not turbid as wind and wave action stir up the sediment and make coverage evaluation difficult.

Also, volunteers were requested to include a general description of the sample area taking note of the overall dominant species present, their approximate coverage in percent and location in reference to the shore.

2.7 Meter for Physical Measures

The YSI meter model 85, measured three physical components of water; temperature (± 0.1 C°), dissolved oxygen (± 0.3 mg/L) and salinity (± 0.1 ppt). The meter probe was placed in the water approximately 7.0 m from shore in the beach seine sweep area. Meter readings were taken either before or after the beach sweep. The location of the meter probe was about half the distance out from shore that the net sweep covered. Location for probe depth was one-half to two-thirds down from the surface.

Once the probe stabilized, the dissolved oxygen, temperature and salinity readings were read and recorded on the data sheet. At every sample location where a beach seine was deployed, physical readings were recorded. These data are summarized in **Tables 1, 2** and **3**.

2.8 Substrate

In September, a sample of benthic substrate was collected from each sample station to analyze moisture content, organic content and grain size of the sediment. Using a garden trowel, a sample of the surficial 10 cm layer was obtained from within the 225 m^2 area beach-seined, bagged and returned for refrigeration, usually frozen for later analysis. From each frozen sediment sample, a thawed portion (100 ± 20 grams) was removed and placed in an aluminum pan. Percent moisture was estimated by loss of weight of a pre-weighed sample after drying for 24 h at 70 °C. Organic content was estimated as weight loss following 3 h cooking at 500 °C. Grain size was estimated by 10 min mechanical shaking through a series of sieves. A more detailed description of the procedure for all of the above is included in **Appendix 6**.

2.9 Permits

Each group was able to apply on-line to acquire a sampling permit for scientific purposes. These are available from DFO Gulf region at the following location: http://www.glf.dfo-mpo.gc.ca/pls/inter/ls52_form_print?to_doE=app_form_en_ini&langE=en&application_typeE=enter

Those listed as part of the community group on the Section 52 permit authorizes them to collect, count and release fish species commonly found in estuarine locations. The permit also allows them to collect and transfer species that require further identification.

3.0. RESULTS

Descriptive univariate statistics were used to examine the CAMP data and determine the relative abundance and species richness for each of the Maritime Provinces (for a complete list of the species sampled and their scientific name see **Appendix 3**).

The purpose of this first summary report is to provide an overview of the operation of the CAMP program. Subsequent years of data acquisition will make it possible to attempt to determine some useable health index that can be applied throughout the Gulf Region. Analysis of a minimum of 2 years worth of data will be necessary to look at patterns and trends that may make it possible to determine such an estuary health index. In the interim, initial result analysis will provide a s..nmary of species abundance and species richness index information. Species abundance values were determined by collating the totals for each of the 5 months over the season at each CAMP estuary or a coastal shoreline location. Species richness was calculated by determining the mean of the total number of different species identified at all 6 sites at a location for the month sampled. To compare all baseline locations, the species richness was pooled for all 5 months. Presenting the data in this way allows for comparisons among all the estuary and coastal shoreline sample locations. A particular species or grouped species of invertebrate or fish can be compared from each location. The species richness allows comparisons of diversity among all locations. This information is also available in graphic form on posters developed for each geographical region of the Northumberland Strait.

3.1 Fish and Crustaceans

For the 2004 sample season, a total of 411,165 fish and crustaceans were counted for nine baseline estuaries/ coastal shorelines (3 from M-H. Thériault are included in the nine) within NB, three within NS and three in PEI. The total numbers of different fish species are greater than the crustacean total number by approximately a 3 to 2 ratio. There were 31 different species of fish and crustaceans during the 2004 sample season, twenty-five of those species were fish and six were crustaceans. As mentioned, the fish and crustacean total number of individuals for the effluent sites done by M-H Theriault are included as part of the nine NB baseline sites.

This section will discuss sampling results for sites with five complete months of sampling data. This includes the provinces of NB, NS, and PEI for the following 15 sites; Shediac, Cocagne, Buctouche, Saint Louis de Kent, Baie du Village, Miramichi, Lamèque, Shippagan, and St. Simon (NB); Pictou, Antigonish, and Mabou (NS); and Mill River, Trout River, and Basin Head (PEI).

Results for 2004 will be compared to 2003 where available. The 2003 results for Lamèque, Shediac, Antigonish and Basin Head are comparable with the 2004 results for those 4 sites only. The 2003 locations referred to above were sampled again in 2004. In 2003 twenty-two species of fish and crustaceans were sampled compared to thirty-one species in 2004. There

were eighteen species of fish in 2003, compared to twenty five species in 2004, while the number of crustacean species remained the same for both seasons i.e. six species. The six species of crustaceans were; grass shrimp (*Palaemonetes vulgaris*), sand shrimp (*Crangon septemspinosa)*, rock crab (*Cancer irroratus*), green crab (*Carcinus maenas*), lady crab (*Ovalipes ocellatus)* and mud crabs (*Xanthidae sp.*). Compared to 2003 data, there were seven additional species of fish identified in 2004 – shorthorn sculpin (*Myoxocephalus scorpius*), tomcod (*Microgadus tomcod*), rock gunnel (*Pholis gunnellus*), white barracudina (*Notolepis rissoi*)*, silver rockling (*Gaidropsarus argentatus*), white perch (*Morone americanus*) and alewife (*Alosa pseudoharengus*). *(though only once in only one location)

Interestingly, the most abundant fish and crustacean species were the same for New Brunswick, Nova Scotia, and Prince Edward Island. They were, in order of most abundant; sand shrimp (*Crangon septemspinosa*), both mummichog (*Fundulus heteroclitus*) and killifish (*Fudulus diaphanus*) grouped as *Fundulus* sp., 4-spine stickleback (*Apeltes quadracus*) and Atlantic silverside (*Menidia menidia*).

The more frequently occurring (abundant) species or species groups for each province/zone are graphed to show abundance relationships for three sections of New Brunswick, namely northeastern, central and southeastern. Nova Scotia and Prince Edward Island having 3 locations each are grouped provincially. The graphed data represents the total number of the frequently occurring species or species groups for the 5 months information was collected.

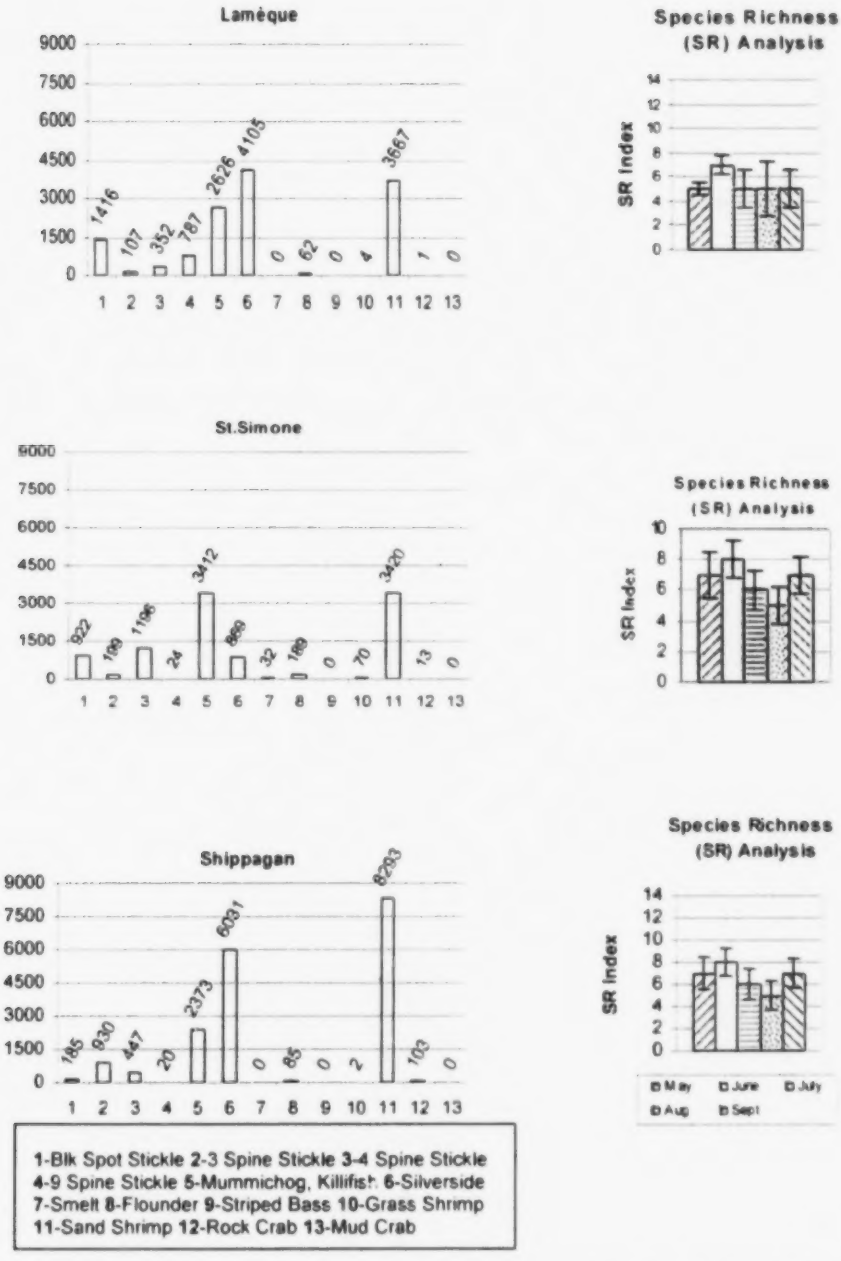

Figure 2. Total cumulative number of individual adult animals in the 13 most frequently occurring species or species groups for the three CAMP locations in northeastern NB sampled over 5 months in 2004. Species richness (total number of species taxa) graph (n = 6 stations per bar, confidence interval at ± 95 %.) for each sample period is also shown.

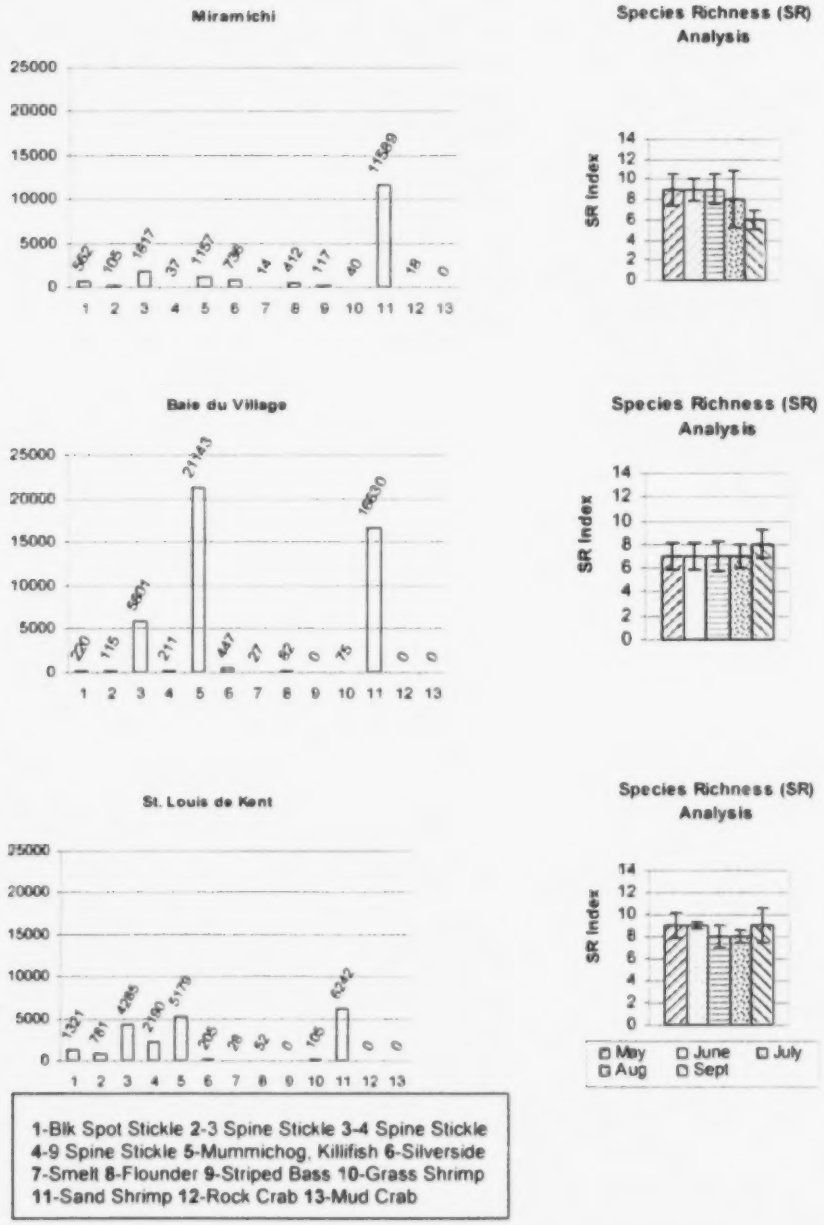

Figure 3. Total cumulative number of individual adult animals in the 13 most frequently occurring species or species groups for the three CAMP locations in central NB sampled over 5 months in 2004. Species richness (total number of species taxa) graph (n = 6 stations per bar, confidence interval at ± 95 %.) for each sample period is also shown.

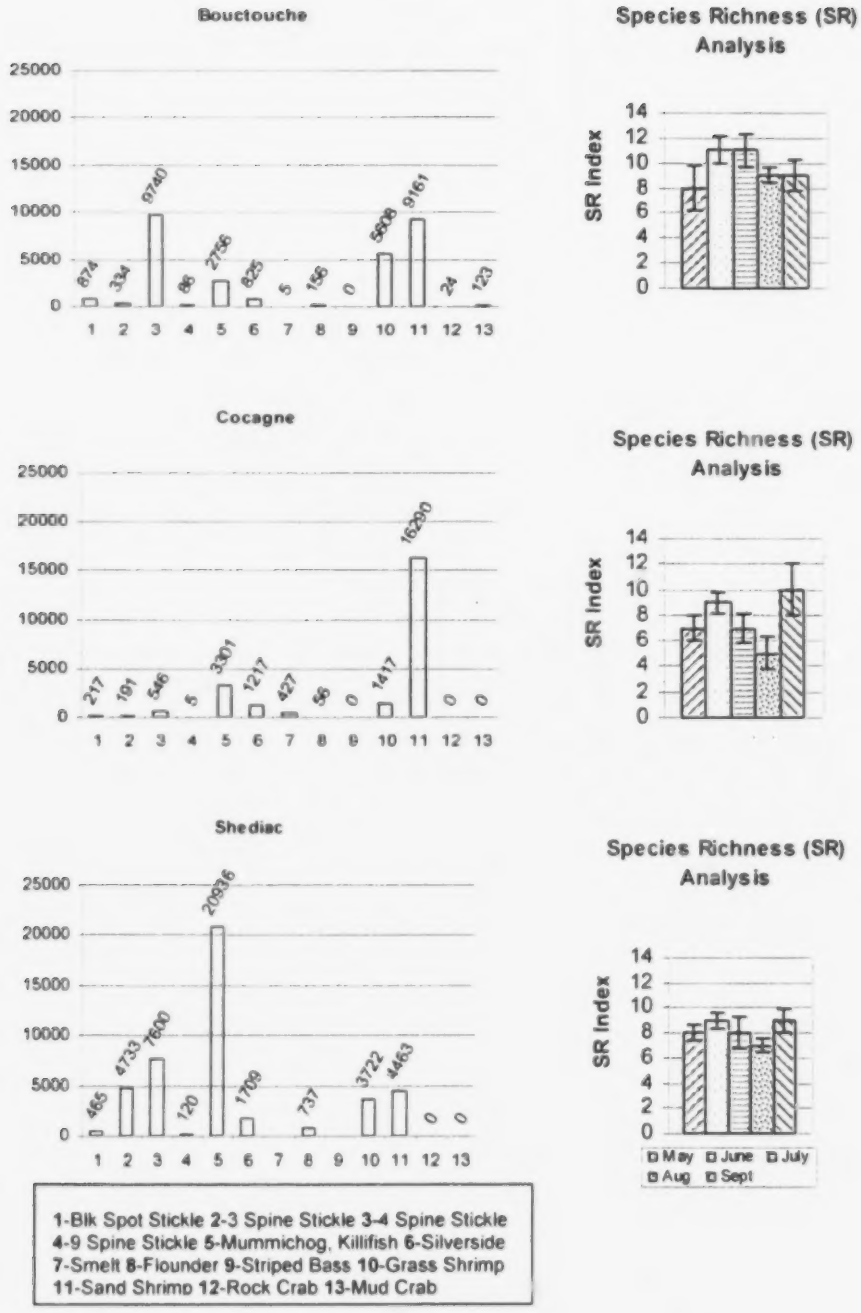

Figure 4. Total cumulative number of individual adult animals in the 13 most frequently occurring species or species groups for the three CAMP locations in southeastern NB sampled over 5 months in 2004. Species richness (total number of species taxa) graph (n = 6 stations per bar, confidence interval at ± 95 %.) for each sample period is also shown.

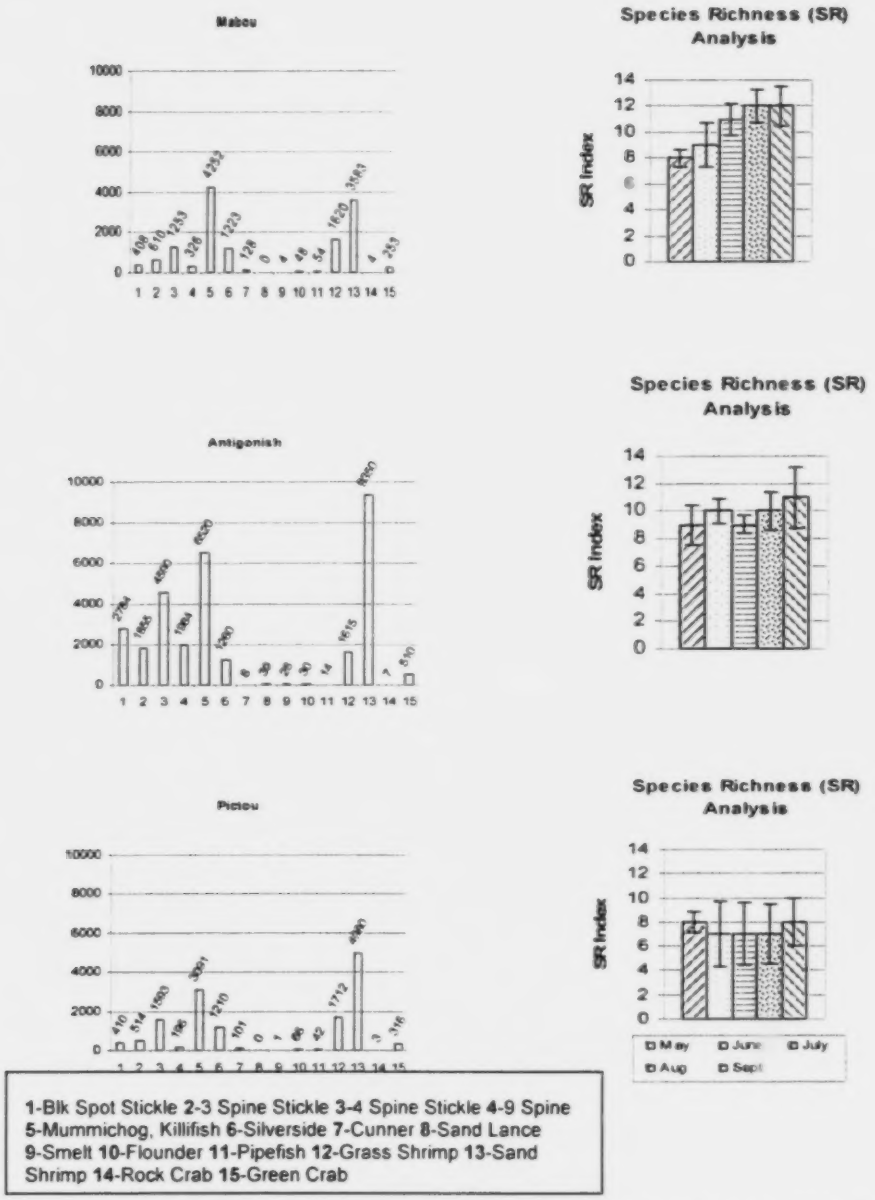

Figure 5. Total cumulative number of individual adult animals in the 15 most frequently occurring species or species groups for the three CAMP locations in Nova Scotia sampled over 5 months in 2004. Species richness (total number of species taxa) graph (n = 6 stations per bar, confidence interval at ± 95 %.) for each sample period is also shown.

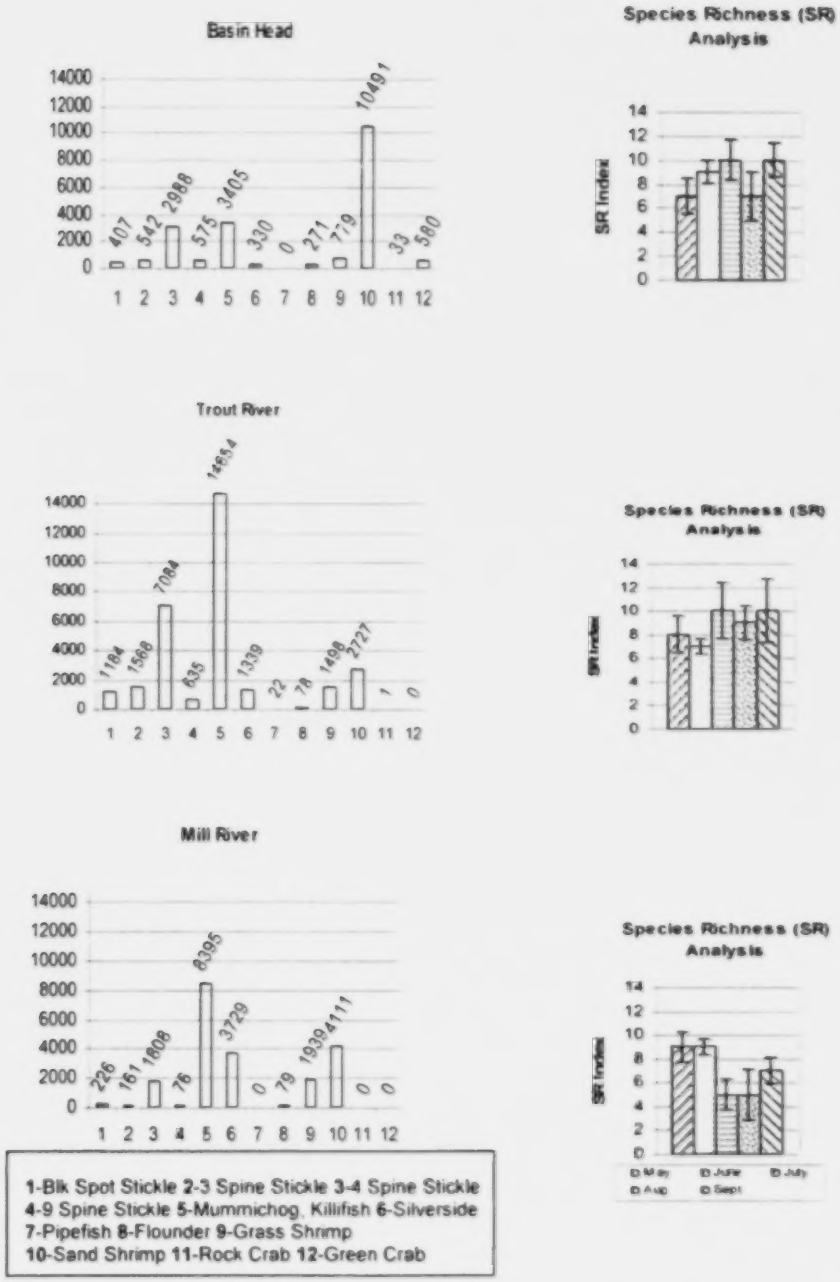

Figure 6. Total cumulative number of individual adult animals in the 12 most frequently occurring species or species groups for the three CAMP locations in Prince Edward Island sampled over 5 months in 2004. Species richness (total number of species taxa) graph (n = 6 stations per bar, confidence interval at ± 95 %.) for each sample period is also shown.

In northeastern NB (**Figure 2**); *Fundulus* sp, silversides and sand shrimp are the 3 dominant taxa. Stickleback populations vary with no definite pattern being obvious. Lamèque, a shallower and warmer site which is probably more euthrophic, has larger numbers of 9 spine sticklebacks. Species richness is generally higher in June in all three locations except Shippagan.

In central NB (**Figure 3**), four spine sticklebacks, *Fundulus* sp. and sand shrimp are the 3 dominant taxa. Stickleback populations show a similar abundance pattern in all locations with higher numbers in the Kouchibouguacis River (St. Louis de Kent). Overall species richness was slightly lower in Baie du Village than the other 2 locations. Species richness appears to drop off in the Miramichi in September as it did in Shippagan in northern New Brunswick.

In southeastern NB (**Figure 4**), grass shrimp are more dominant in numbers than in central and northern New Brunswick. Stickleback numbers are low in Cocagne, with the 4 spine dominating at all 3 locations. *Fundulus* sp. numbers are relatively high especially in Shediac. Species richness is fairly stable all season with small peaks in June and September. Higher species richness numbers in September is in contrast to the lower values observed in central and northern New Brunswick. Monthly, the average species richness varied considerably, and at this time, no pattern can be discerned between sites or stations, from month to month. A more in-depth statistical analysis will be undertaken after data sets for successive years are available.

In Nova Scotia (**Figure 5**), *Fundulus* sp. and sand shrimp are the 2 most abundant taxa at all 3 locations. The 4-spine is the most abundant stickleback in all 3 locations. Silversides show similar numbers at all locations. Species richness is greatest in Mabou Harbour estuary. Pictou and Antigonish show small peaks of species richness in September.

In Prince Edward Island (**Figure 6**), *Fundulus* sp. and 4-spine sticklebacks are the most abundant fish taxa at all three baseline sites. Silversides were more abundant at Mill River than at the other two Prince Edward Island sites. Sand shrimp are the more abundant crustacean at all sites, as they are through-out the Gulf region. Species richness fluctuates throughout the sampling season, though September seems stable at Basin head and Trout River compared to a slight decline at Mill River.

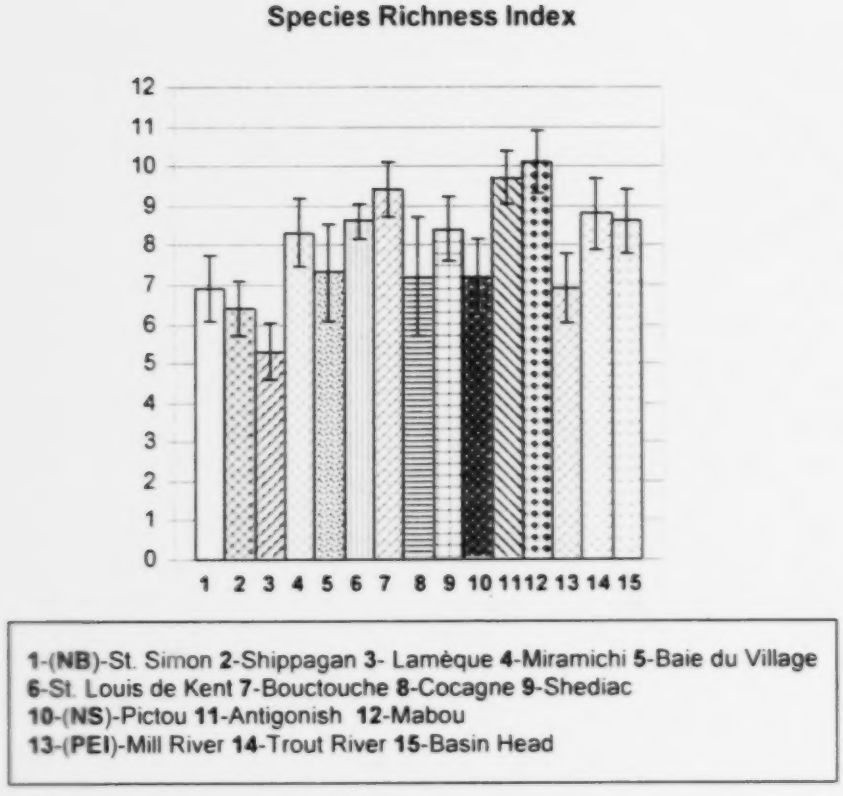

Figure 7. The mean species richness with a confidence interval at ± 95% (n = 5) for 15 baseline estuary locations along the Northumberland Strait over a 5 month period.

Figure 7 provides a summary of all 6 sample sites, for all months for each of the 15 baseline estuaries or coastal shoreline locations. The species richness for all five months was averaged to arrive at the reference value shown in the graph. At this time the combined data provide a baseline reference point. When more information is available, environmental science personnel will examine the successive year data for patterns and trends.

In the province of New Brunswick, Buctouche had the highest average species richness for the five month sampling period at ~ 9.4 species ± 0.6821, the lowest average species richness was in Lamèque at ~5.3 species ± 0.7042. In Nova Scotia, Mabou Harbour has the higher value of species richness value at ~ 10.1 ± 0.7769 and Pictou Harbour has the lowest at ~ 7.2 species ± 0.9369. In PEI, Basin Head and Trout River have species richness values that are close together at ~ 8.6 species ± 0.8121 and ~ 8.8 species ± 0.9018, respectively. Mill River has the lower value at ~ 6.9 species ± 0.8732.

3.2 Macrophytes

The dominant vegetation type was submerged eelgrass beds. Normally the eelgrass bed was located in the outer 1/3rd or outer 1/5th of the net sample sweep area. If a vegetation bed was present the number of fish and invertebrates collected was generally higher as more habitats for pelagic species was available. If the bottom type was sand dominated, less eelgrass was present. Sites with larger rocks are likely to include species of rockweed (usually *Fucus vesiculosus*). Other abundant macrophytic vegetation includes filamentous green algae (*Cladophora sp.*) and sea lettuce (*Ulva lactuca*). In northern NB and at a few NS sites hollow green weed (*Enteromorpha intestinalis*) was noticeable but not abundant. On occasion, volunteers have found pieces of kelp species (*Laminaria*) and green fleece (*Codium fragile*) pieces as floating wash-in trapped by the net sweep. These species are usually attached by a holdfast in deeper water. Generally, upper estuary sites in the river system contain more eel grass beds than the outer portion that is closer to the mouth or associated with a beach area. Vegetation type is important as it defines the variety of available habitats. Preference of YOY pelagics and juvenile crustaceans for protective cover from predators translates into greater numbers when vegetation is present.

The quadrat method is effective when the water has not been stirred up. Volunteers find it difficult to get bottom profile information when wind and waves make observations more difficult. The use of a viewing bucket or waterscope was encouraged. The NGO's were instructed to make a detailed record of the characteristics of the bottom profile for each sample location in May so comparisons could be made as the season progressed. Overall, the sites did not change much over the season, except for growth of the existing attached vegetation. One concern to NGO volunteers was the accumulation of unattached material in the beach seine at a sample location. Algae such as sea lettuce and eelgrass could hinder the effectiveness of collections by smothering fish before they could be counted and released.

3.3 Physical Measures

At each sample site and at every location, three physical parameters were measured. Data for salinity, temperature and dissolved oxygen gave a monthly snapshot that provided an overview of seasonal change. The upper sample sites in each estuary had lower salinities and considerable fluctuation depending upon state of the tide, as expected. There was considerable variation in dissolved oxygen.

Table 1. Average monthly temperature (± S.D.) per location for the 2004 season (n = 6).

			Temp (^{0}C)		
N.B.	May	June	July	Aug	Sept
St-Simon	**14.1 ± 2.3**	**20.3 ± 1.9**	**21.2 ± 1.8**	**16.8 ± 0.7**	**7.3 ± 1.1**
Lamèque	**11.4 ± 1.1**	**16.4 ± 1.4**	**23.4 ± 0.5**	**19.7 ± 1.9**	**9.5 ± 1.5**
Shippagan	**11.0 ± 1.0**	**18.7 ± 1.4**	**22.4 ± 1.8**	**16.2 ± 1.9**	**12.1 ± 1.4**
Miramichi	**12.7 ± 1.9**	**17.5 ± 1.6**	**21.6 ± 1.1**	**21.8 ± 0.6**	**14.4 ± 1.4**
Baie du Village	**10.3 ± 0.8**	**n/a**	**22.2 ± 2.1**	**21.0 ± 1.9**	**18.6 ± 2.2**
St Louis	**11.1 ± 0.5**	**18.1 ± 0.5**	**23.9 ± 2.1**	**23.0 ± 0.9**	**17.8 ± 0.5**
Bouctouche	**10.2 ± 1.1**	**19.1 ± 1.3**	**20.3 ± 0.5**	**20.8 ± 0.4**	**14.0 ± 1.0**
Cocagne	**15.2 ± 1.5**	**20.0 ± 1.1**	**23.8 ± 2.3**	**24.2 ± 1.7**	**16.5 ± 3.0**
Shediac	**14.5 ± 1.4**	**15.0 ± 1.4**	**20.3 ± 1.5**	**24.4 ± 0.6**	**19.4 ± 0.5**
N.S.					
Pictou	**12.8 ± 3.3**	**19.0 ± 3.7**	**21.9 ± 4.4**	**22.7 ± 3.3**	**13.8 ± 1.4**
Antigonish	**12.3 ± 2.9**	**16.8 ± 1.2**	**22.3 ± 0.5**	**21.9 ± 1.6**	**13.1 ± 1.6**
Mabou	**7.9 ± 0.7**	**15.0 ± 0.7**	**21.8 ± 0.9**	**20.4 ± 0.9**	**13.2 ± 0.5**
P.E.I.					
Mill River	**12.6 ± 0.4**	**17.9 ± 0.7**	**24.5 ± 0.7**	**22.0 ± 0.5**	**8.1 ± 1.5**
Trout River	**11.8 ± 1.6**	**16.7 ± 0.7**	**24.0 ± 2.4**	**22.2 ± 0.9**	**16.3 ± 1.3**
Basin Head	**7.6 ± 0.7**	**12.9 ± 1.1**	**20.0 ± 1.0**	**18.3 ± 0.7**	**14.8 ± 0.4**

Each estuary has its own temperature characteristics. Table 1 reflects the average temperature on the day of sampling of all sites on the estuary. There are individual differences depending on whether the sample site is inner estuary, middle or outer. Temperature was obviously related to increasing air temperatures as the season progressed; hence the warmest temperatures occurred in July and August. Outer estuary sample sites were generally cooler due to contact with cooler oceanic water from Northumberland Strait. Inner estuary sample sites are generally warmer as they are influenced by the warmer inland run-off waters of the estuary. By only taking one reading on the sampling day, seasonal trends and the factors that might affect change are not addressed in this report.

Table 2. Average monthly salinity (± S.D.) per location for the 2004 season (n = 6).

			Salinity (ppt)		
N.B.	May	June	July	Aug	Sept
St-Simon	**24.1 ± 1.0**	**26.4 ± 1.5**	**25.6 ± 1.2**	**25.5 ± 1.1**	**24.2 ± 2.0**
Lamèque	**26.7 ± 0.4**	**26.9 ± 0.3**	**27.3 ± 0.3**	**24.5 ± 3.1**	**26.5 ± 0.4**
Shippagan	**26.7 ± 1.8**	**27.3 ± 0.4**	**27.5 ± 0.4**	**27.0 ± 0.3**	**27.0 ± 0.5**
Miramichi	**11.1 ± 7.3**	**16.5 ± 6.2**	**12.9 ± 7.8**	**15.4 ± 6.4**	**14.0 ± 8.6**
Baie du Village	**25.5 ± 0.7**	**n/a**	**26.6 ± 1.3**	**26.5 ± 0.9**	**25.3 ± 0.7**
St Louis	**9.9 ± 1.9**	**18.5 ± 0.7**	**10.6 ± 1.2**	**17.6 ± 2.5**	**12.4 ± 1.2**
Bouctouche	**20.6 ± 5.9**	**23.3 ± 1.9**	**26.8 ± 0.5**	**27.2 ± 0.4**	**23.2 ± 1.1**
Cocagne	**26.4 ± 0.5**	**28.6 ± 0.1**	**28.5 ± 0.1**	**29.4 ± 0.2**	**26.1 ± 0.5**
Shediac	**15.0 ± 0.9**	**25.3 ± 1.6**	**27.2 ± 0.6**	**28.6 ± 0.3**	**20.4 ± 3.3**
N.S.					
Pictou	**21.9 ± 5.8**	**26.6 ± 2.3**	**27.2 ± 2.0**	**27.5 ± 1.6**	**22.9 ± 8.3**
Antigonish	**23.9 ± 3.7**	**23.9 ± 3.9**	**23.8 ± 4.6**	**26.1 ± 3.9**	**24.8 ± 5.3**
Mabou	**25.3 ± 1.5**	**20.6 ± 4.3**	**18.6 ± 4.2**	**27.2 ± 1.5**	**24.0 ± 3.6**
P.E.I.					
Mill River	**22.7 ± 3.0**	**24.4 ± 1.2**	**23.7 ± 2.6**	**25.2 ± 1.3**	**19.9 ± 3.5**
Trout River	**24.1 ± 4.2**	**22.1 ± 7.6**	**21.9 ± 7.2**	**23.7 ± 3.1**	**24.2 ± 2.3**
Basin Head	**28.5 ± 1.5**	**29.0 ± 0.5**	**33.4 ± 18.2**	**27.9 ± 0.8**	**27.8 ± 0.8**

Salinity varied extensively among sites, at different sampling times and within each estuary. However, when monthly averages were examined seasonal variations were not extreme. If the tide was just starting to recede in the upper estuary, the salinity would naturally be higher than if the tide had not come in yet due in part to greater influence from headwaters leaving the estuary. As much as possible, groups attempted to sample on a similar tide regime each month. Lower salinities are noted for St.Louis and Miramichi estuaries and they were sampled further up the estuary that other sites in NB. These two longer estuaries have lower salinities in the upper sites and higher salinities at the mouth; therefore the lower values indicated are reasonable as more input from headwater run-off can have a major influence. There is monthly variation whose anthropomorphic cause is probably a combination of many factors. The dominant pattern is that summer months have slightly higher salinities for most locations.

Table 3. Average monthly dissolved oxygen (± S.D.) per location for the 2004 season (n = 6).

			Dissolved O_2 (mg/l)		
N.B	**May**	**June**	**July**	**Aug**	**Sept**
St-Simon	9.4 ± 0.3	6.6 ± 0.3	6.1 ± 1.0	8.3 ± 0.6	9.2 ± 0.5
Lamèque	8.5 ± 0.9	7.4 ± 1.4	4.2 ± 2.1	8.4 ± 1.4	10.0 ± 1.6
Shippagan	9.6 ± 0.9	9.5 ± 0.7	5.3 ± 1.1	9.5 ± 1.3	10.7 ± 0.9
Miramichi	9.2 ± 1.1	9.5 ± 1.3	8.5 ± 1.2	6.1 ± 2.2	8.3 ± 0.9
Baie du Village	10.5 ± 0.3	n/a	8.6 ± 1.8	10.8 ± 3.4	9.9 ± 1.0
St Louis	9.9 ± 1.3	9.1 ± 0.8	9.1 ± 1.8	9.2 ± 2.1	8.7 ± 0.5
Bouctouche	11.2 ± 5.5	8.8 ± 0.3	7.3 ± 0.6	6.9 ± 0.4	8.6 ± 0.4
Cocagne	10.3 ± 0.3	10.3 ± 1.1	10.3 ± 3.5	6.6 ± 1.6	9.5 ± 2.0
Shediac	8.7 ± 0.2	9.0 ± 0.2	8.8 ± 1.9	7.2 ± 1.1	7.3 ± 0.7
N.S.					
Pictou	8.6 ± 1.7	7.6 ± 0.6	6.4 ± 1.3	6.4 ± 1.8	8.1 ± 3.0
Antigonish	9.1 ± 0.5	7.8 ± 0.8	7.4 ± 0.9	6.8 ± 0.8	7.6 ± 0.6
Mabou	10.1 ± 0.2	8.7 ± 0.5	9.9 ± 8.3	7.2 ± 0.6	7.0 ± 1.3
P.E.I.					
Mill River	10.4 ± 0.7	10.8 ± 1.1	8.8 ± 2.3	7.0 ± 1.4	10.6 ± 1.6
Trout River	13.5 ± 4.4	11.1 ± 1.3	11.1 ± 4.0	6.3 ± 0.6	8.5 ± 1.4
Basin Head	9.7 ± 0.5	10.3 ± 0.8	8.2 ± 0.9	6.9 ± 0.4	8.3 ± 0.6

Dissolved oxygen values were generally highest in the spring sampling and decreased as the summer progressed. This can be tied to temperature as higher temperatures mean a lower capacity for water to hold oxygen. Notable low levels of DO are in areas known for effluent run-off or areas with a large quantity of detrital plant matter. This could be the case in Lamèque and Shippagan as shown by the lowest values recorded in July. By September, most locations showed a noticeable increase in DO again as the water temperature cooled and plant matter production decreased.

3.4 Sediments

In late August or September, one sediment sample was taken at every sample site. Overall, the 2 dominant sediment types were sand and mud. Higher vegetation coverage, which is directly related to bottom type, was generally observed in muddy areas.

This sediment analysis was completed in the fall by lab technicians at DFO Gulf region. A more detailed description of the procedure is included in **Appendix 6**.

Table 4. Summary of % moisture, average organic content (± S.D.) and mean grain size for the baseline locations (n = 6).

	% Organic	% Moist	mean Grain Size (mm)
N.B.		**September**	
St-Simon	1.91 ± 0.48	21.99 ± 0.55	0.280 ± 0.130
Lamèque	1.99 ± 0.81	22.72 ± 1.21	0.361 ± 0.188
Shippagan	1.38 ± 0.32	26.09 ± 9.34	0.340 ± 0.066
Miramichi	2.42 ± 3.14	23.54 ± 12.97	0.365 ± 0.101
Baie du Village	1.12 ± 0.36	22.30 ± 1.62	0.606 ± 0.690
St. Louis de Kent	2.16 ± 0.63	25.46 ± 3.58	0.207 ± 0.031
Bouctouche	3.28 ± 1.41	33.95 ± 8.01	0.215 ± 0.031
Cocagne	1.34 ± 0.98	23.17 ± 7.11	0.422 ± 0.521
Shediac	1.59 ± 0.98	27.32 ± 5.53	0.314 ± 0.104
N.S.			
Pictou	3.91 ± 4.24	32.03 ± 15.47	0.233 ± 0.151
Antigonish	3.65 ± 3.72	23.44 ± 14.54	n/a
Mabou	11.29 ± 13.77	18.42 ± 12.41	n/a
P.E.I			
Mill River	0.53 ± 0.2	27.34 ± 3.98	0.215 ± 0.080
Trout River	2.46 ± 1.79	33.02 ± 9.28	0.180 ± 0.036
Basin Head	4.00 ± 5.96	36.81 ± 18.81	0.248 ± 0.091

In New Brunswick, Bouctouche has the highest percentage organic and percentage moisture contents compared to all other locations. High organic content and percentage moisture usually means we are dealing with a mud bottom. Bouctouche also had the second smallest average grain size. Baie du Village has the lowest percentage organic and percentage moisture contents and the largest average grain size. Mabou Harbour in NS and Basin Head in PEI have the highest values for percentage organic and percentage moisture for the estuaries in their provinces.

Table 5. Summary of the dominant bottom type for each estuary location and the percentage vegetation cover of 6 sample locations.

N.B.	# Sites Mud	# Sites Sand	# Sites Rock	% Vegetation
St-Simon	1	5	0	10
Lamèque	2	3	1	10
Shippagan	0	4	2	15
Miramichi	2	4	0	5
Baie du Village	2	3	1	5
St. Louis de Kent	3	3	0	15
Bouctouche	2	4	0	10
Cocagne	2	4	0	5
Shediac	3	3	0	5

N.S.	# Sites Mud	# Sites Sand	# Sites Rock	% Vegetation
Pictou	2	4	0	5
Antigonish	2	4	0	10
Mabou	1	4	1	5

P.E.I	# Sites Mud	# Sites Sand	# Sites Rock	% Vegetation
Mill River	0	5	1	5
Trout River	2	3	1	5
Basin Head	1	5	0	0

The locations with more mud sites (3) were in St. Louis de Kent and Shediac. St. Louis has the smallest mean grain size and third largest percentage organic and moisture contents. The majority of the sample locations were characteristically sandy close to shore where beach seining occurred. Often the mud was farther offshore and a beach seine operation would sample over this substrate when the tide was out.

Vegetation cover is a qualitative measure since some is attached (eelgrass and rockweed) and some is floating as was observed with sea lettuce. The spring observations were lower values but as a season progressed, the vegetation present generally increased. St. Louis de Kent has more mud sites and more vegetation than all other locations.

4.0 DISCUSSION

The CAMP program has already proven to be a popular method for gathering data for estuaries and coastal shorelines. From an initial group of four estuaries in 2003, participation grew to 24 in 2004. Some of these 24 had limited involvement in 2004, but planned to expand to baseline status (full sampling season) in 2005. This shows a major interest on the part of community groups to be involved. In addition, it has demonstrated that DFO, working in conjunction with community groups can provide an avenue for developing stewardship of local resources. As a vehicle for public education, CAMP has had a positive impact. Almost 50 individuals, including high school and university students, and interested members of the general public from teens to retirees were trained in the rudiments of fish and invertebrate identification and the basics of formal data collection for environment assessment. The involvement of non-professionals in CAMP activities has thus been a source of important public education and outreach on the part of DFO.

A major benefit for all CAMP participants is the realization that estuaries contain diverse and abundant biota. This removes a general perception that estuaries are simply 'mud holes' with eelgrass that fish must swim through to reach fresh water. CAMP participants have observed first hand the many species that are critical to estuarine ecosystem functioning. Consequently, individuals involved with CAMP have acquired direct knowledge of the importance of estuaries to the environmental health of their communities.

It is beyond the scope of this report to provide a detailed analysis of the actual data on temporal and geographic variation in species abundance and community structure, and to link this with particular attributes of the environment. This analysis will be done and reported under separate cover. Regardless, a number of primary objectives of CAMP have been met or partially met. Baseline data have been collected from a variety of estuaries in the Gulf of St Lawrence spanning three provinces. Many community groups now have the knowledge base to continue their assessments of environmental conditions and potential problems both within CAMP and by applying the approaches derived from CAMP to other locations.

The next steps for CAMP are now in the hands of the DFO and their associated university collaborators. The baseline data derived from two to three years of community efforts will be used to develop a tool for determining whether an estuary as a whole, or individual sites within an estuary have viable and sustainable biological communities. For example, is it overall species richness or species diversity that provides the best single metric for estuarine health? Can the absence or presence or abundance of particular species reflect particular environmental problems? When these and related questions have been addressed and the resulting conclusions have been returned to the participating community groups and the public at large, CAMP will have fulfilled its immediate objectives. Subsequently, community groups will continue to monitor the health of their estuary / coastal shoreline using the health index tool.

4.1 Fish and Crustaceans

In northeastern NB; sand shrimp, silversides and mummichogs were found in high numbers. In central NB; sand shrimp, mummichogs and 4-spine sticklebacks were the three most

abundant organisms collected. In southeastern NB; sand shrimp, mummichogs and 4 spine sticklebacks also dominated the total counts. One noticeable observation was that there were more grass shrimp in southeast NB than other parts of the province.

The 3 dominant species in NS were sand shrimp, mummichogs and 4 spine sticklebacks. Green crab was found in all locations of NS.

In PEI, the dominant species collected included sand shrimp, mummichogs and 4 spine sticklebacks. Green crabs were only found in Basin Head. Grass shrimp and many silversides were dominant in the beach seines.

In some NB locations (Miramichi, Shippagan, St. Simon), the species richness dropped off in September. The others remained the same and two (Baie du Village and Cocagne) increased.

The data for 2004 supported the observation in 2003 that species richness was lower in Lamèque than in Shediac, Antigonish and Basin Head.

The Buctouche estuary had high species richness and this leads to the question of whether this is in spite of or the result of high organic levels in the sediments. Mabou in NS showed a similar pattern. Some of the CAMP locations are in close proximity to processing plant outlets. Species richness was lower compared to other NB locations but abundance can often be higher, possibly due to excess nutrient availability (Shediac, Cocagne, Baie du Village, Lamèque). This is not easily verifiable as most estuaries in the Gulf region have some degree of nutrient input. At this point in the CAMP program there is an indication that abundance and species richness may provide some signal of nutrient levels in estuaries.

4.2 Macrophytes

Vegetation profiles of the sample locations did not undergo major qualitative change over the sampling season unless there was a measurable disturbance, such as a winter ice scour. The species of vegetation that were catalogued in May generally remained the same in September. The measurable change was a noticeable increase in the density of vegetation. This was most noticeable in mud bottom substrates where eel grass dominated the outer edge of the sample area. Natural growth processes proceeded with normal summer increase of the quantity of vegetation present.

As the season progressed, sample areas that experienced less water movement or were in sheltered inlets had a tendency to collect larger amounts of sea lettuce and/or eelgrass debris. A station could change with respect to the amounts of suspended and floating plant material it contained as the summer progressed. As mentioned, excessive quantities of plant debris can be a problem for fish survival during collection sweeps.

Many of the outer estuary sites were characterized by a dominant sandy/rocky substrate. The vegetation consisted of rockweed attached to rocks in the sample sweep area. Also present, especially later in the summer, were tufts of filamentous green algae. There were very few sites where no vegetation was present. These were exclusively sandy bottom sites.

4.3 Physical Measures

Physical measures were taken as part of the CAMP collection protocol. They did provide a monthly measure of changes that occur at sample locations, but they are only one measure per

month. There were no anomalies in that temperature was colder in the spring, warmed as the summer progressed and cooled off a bit in the fall. Scott and Scott (1988) indicate that most sticklebacks prefer temperatures above 10 ^{0}C for spawning. Only Mabou (NS) and Basin Head (PEI) had temperatures below this value in May. For the 2005 season, it is planned that temperature profilers will be installed in each sample estuary to provide a continuous record of change throughout the sample season.

Salinity shows more variation. In the upper estuary samples, salinity was lower as expected due to larger fresh water input. Middle locations would vary and this can be attributed to the state of the tide. Incoming tides or rising tides would bring in more salt water as compared to the increase in fresh water at mid location when the tide was receding.

Dissolved oxygen concentrations can be related to estuary health in that organisms require adequate levels to survive. Trout and salmon for example prefer levels above 4 mg/l. Dissolved oxygen preferences for permanent estuary/coastal shoreline species are not well documented. The general pattern of oxygen levels in the estuary was higher quantities of O_2 in the spring that subsequently dropped in the summer and increased again in the fall. In locations where there was more organic matter, such as near seafood processing plants, decomposition of organic matter could produce the lower oxygen levels recorded. Other processes that allow oxygen input include photosynthesis by plants and mixing from the air due to turbulence.

4.4 Sediments

The sediment samples were analyzed in early fall 2005. In New Brunswick, the sediments generally had low organic content; 1 to 2 percent at most sample locations in the estuaries. One site, Bouctouche, recorded an average organic content above 8 percent. In Nova Scotia, there was more variation in the range of measured total organic content; also sites in NS estuaries had the higher values for total percent moisture. Organic content ranged from less than 1 percent to a high of 4 percent in Prince Edward Island.

One general observation is that mud bottoms with characteristic small mean grain size had higher percent organic content and higher percentage moisture content. The opposite patterns exist for sandy bottom locations.

5.0 CONCLUSION

The initial goal of setting up a monitoring program that is community group friendly has been realized. DFO alone does not have the resources to undertake a study of the scope of CAMP. DFO will continue to supply beach seines and YSI meters and continue to assist with the coordination of the program. The community groups are the backbone to the success of the program. Community groups have been diligent in collecting the baseline data required. They anticipate that the data they have gathered will be useful in developing an authoritative tool to help them monitor the health and condition of their estuary. Besides a commitment to quality data recording, the community groups realize they have only had to contribute resources for one day a month to acquire these data. The integrated approach provided by the University partners, DFO and certain funding agencies has helped guide the development of the CAMP program to a direction that will maximize output goals from minimal input.

There is an expectation that more specialized science could easily be developed from the outcomes of the present CAMP data. The fundamental objective of the CAMP program is to develop a measure of ecological health that will be based on a large data set that will not involve expensive scientific processes.

The protocols established at the outset of the program have generally been strictly adhered to, with quality adjustments being made to various protocols and methods that have improved the consistency of data acquisition.

ACKNOWLEDGEMENTS

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After the initial set-up of the pilot stage by several of the authors, the continued support and consultation throughout the 2004 sampling season by William Ritchie ensured that the program maintained strong links to the original concept. Thanks also to Sylvie Robichaud for the 2004 sediment analysis in 2005.

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APPENDICES

Appendix 1. Description of Sampling Equipment

Beach Seine

A beach seine (30 m X 2 m high; 6 mm mesh, with a central bag) is a net that allows for the capture of demersal and pelagic fish and crustaceans. One person walks the net 15 m out from shore, then turns and walks 15 m parallel to shore, and then returns to shore while a second person anchors the other end of the net to shore. The head rope, with floats, is on the surface, while the footrope, containing a lead line, is in contact with the bottom, creating a barrier to prevent the fish from escaping the area enclosed by the net.

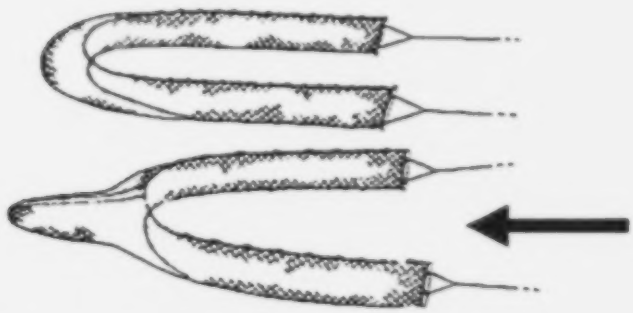


Figure 8: Two basic types of beach seines used in 2004, the second with a larger collection bag. (the arrow indicates the one used for the majority of CAMP locations).

Quadrat

A quadrat is an instrument for estimating the % cover of plant species present at a sampling site. Essentially it is one large square (50 x 50 cm) that is subdivided into four smaller squares or sub-quadrats with string. It is used in relatively shallow water, where it surrounds rooted plant species on the substrate, and where the enclosed vegetation is easily observed by a viewer.

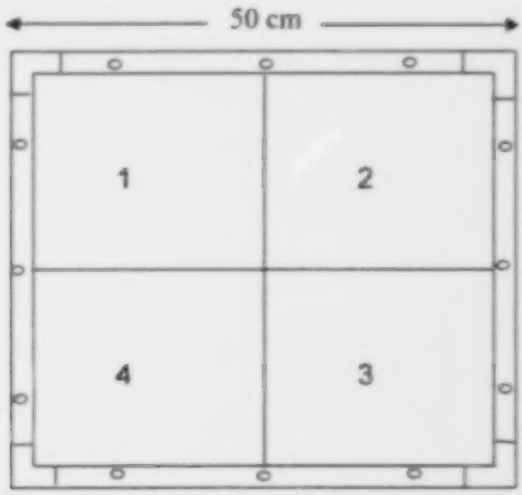


Figure 9: A quadrat constructed of copper pipe. (String to make 4 sections, drilled holes so it sinks and drains) (FAO, 2000-2004).

YSI Model 85

DFO purchased and supplied these meters to the community groups for use with the CAMP project. Also they have the opportunity to use them on other estuary related projects. Basic physical measurements are recorded each sampling session for each site. These basic physical oceanographic measures include salinity, temperature and dissolved oxygen. Calibration of the YSI has been the responsibility of the Area Offices while maintenance of the device in the field is a shared undertaking of both the community group and the Area Office. The meters are returned to DFO at the end of each sampling season and re-distributed the following spring.

Appendix 2. Detailed Description of Sampling Protocols, Discussion of Collection Procedure Problems and Net Protocols

What to do when... a large rock is caught in the net

As the net is being pulled, certain hindrances that may stop the natural movement of the net can be a large rock or a piece of wood thatmay snag the lead line. The hauler must identify that the net is not moving normally and stop pulling or the net may tear. Another person must move along the outside of the net and locate the impedance. With their foot or preferably their arm, they have to lift the lead line over the impedance with minimal vertical rising so that fish cannot escape.

What to do when ..... there is excessive quantities of plant debris in the net

When volunteers arrive at the site initially, the presence of excess plant debris can usually be determined visually. Sea lettuce is the species that presents a problem most of the time.

This can be minimized with careful site selection beforehand. If the plant debris is an ongoing problem, the site should be changed to a location adjacent to the original site. Also, remember that shoreline debris can be removed manually before the net is hauled in to shore. As the hauler is in the water they can choose a certain path that may reduce the debris collection without compromising the hauling integrity.

If unavoidable, one method is to remove the lettuce as the net is hauled in with a rake or fork. Shake the full fork inside the area of collection and throw the debris outside the net. The fish will escape the debris and remain in the collection area if the plant material is not compressed. This would be necessary if the net cannot be moved because the mass of plant material is too heavy.

Another strategy is to go directly to the bag, and do a sub-sample of fish and determine population percentages. Usually, a lot of plant debris can be indicative that fish numbers will be large.

What to do when ..... the seine pocket is full of fish

At certain sites and at certain times of the year many schools of fish can be collected in the net sweep, sometimes in the thousands for certain species. In these situations, the collection will easily exceed the 300 number for certain species. Record the species as greater than 300 and estimate what you think the number is for the remainder using the following methodology.

The first step is to identify which species are assured to exceed the 300 number. You can anticipate that mummichogs, sticklebacks, silversides and sand shrimp will be the species where this will be encountered most often.

Take five dip net samples, being conscious to sweep the box horizontally and vertically. Count everything in the dip net. Then determine the average for each of the species that will exceed 300. This number will be used to extrapolate the total numbers estimate after you

count the total number of dip nets used to empty the box. If the volunteers available make 5 sub-samples impractical or if you anticipate that fish will begin to die before sampling is complete then reduce the number of sub samples to two. Also be aware that the standardized dip net size does not have to be full to the top, but dip nets should be identical in size.

A specific example will help to illustrate this.

First dip: 15 mummichog, 12 silversides, 10 4-spine sticklebacks and 22 sand shrimp.
Second dip: 14 mummichog, 9 silversides, 7 4-spine sticklebacks and 27 sand shrimp.
Third dip: 11 mummichog, 14 silversides, 9 4-spine sticklebacks, 12 sand shrimp.
Fourth dip: 19 mummichog, 13 silversides, 7 4-spine sticklebacks and 23 sand shrimp.
Fifth dip: 18 mummichog, 12 silversides, 5 4-spine sticklebacks and 15 sand shrimp.
Totals: 77 mummichog, 57 silversides, 38 4-spine sticklebacks and 99 sand shrimp.

Divide totals by 5 (1 decimal place) becomes:

15.4 mummichogs, 11.4 silversides, 7.6 4-spine sticklebacks and 19.8 sand shrimp.

There were a total of 37 dips so the rough estimate becomes: 570 mummichogs, 422 silversides, 281 4-spine sticklebacks and 733 sand shrimp.

After the ratio is determined, the abundant species can be released as quickly as possible, but you still have to examine and record all other species that occur in smaller numbers as you empty the dip net. Remember that even if we take a sub sample we might miss the less numerous species. These are important to the species richness index for the site. It is recommended that it is always best to go through the whole catch even if it is a huge one. This has to be done as quickly as possible to minimize the mortalities. Remove those most susceptible to oxygen deprivation as soon as possible such as juvenile smelts and silversides. This sensitivity to oxygen deprivation can be more pronounced in the warmer months.

Another situation to be aware of is the abundance of fish present when manpower resources are minimal. In this case, the sampler should only do the above procedure with 2 sub-samples.

One problem we encounter occasionally is the case when the bag (and sometimes the wings) can be too full fish to haul and empty in the box. In those rare occurrences, your one option is to use a small bucket to scoop out a sample and pour into the box. Then the above method can be used. You have to decide how many buckets will provide a representative sample. Again the problem of less numerous and benthic species has to be addressed. Crabs and flounders will be on the bottom and so you will have to sweep the bottom of the net as best as possible. Or, consider removing enough buckets of fish to the point where the bag can now be emptied. Although incidences of excessive quantity of fish have occurred in the past, it is not a frequent occurrence.

Appendix 3. List of Species Collected During the CAMP Program 2004

fish

alewife (gaspereau) (*Alosa pseudoharengus*)
American sand lance (*Ammodytes hexapterus*)
Atlantic silverside (*Menidia menidia*)
Atlantic tomcod (*Microgadus tomcod*)
banded killifish (*Fundulus diaphanus*)
black spotted stickleback (*Gasterosteus wheatlandi*)
blueback herring (*Alosa aestivalis*)
brook (speckled) trout (*Salvelinus fontinalis*)
cunner (*Tautogolabrus adspersus*)
four spine stickleback (*Apeltes quadracus*)
nine spine stickleback (*Pungitius pungitius*)
northern pipefish (*Syngnathus fuscus*)
mummichog (*Fundulus heteroclitus*)
rainbow smelt (*Osmerus mordax*)
rock gunnel (*Pholis gunnellus*)
shorthorn sculpin (*Myoxocephalus scorpius*)
silver rockling (*Gaidropsarus argentatus*)
smooth flounder (*Pleuronectes putnami*)
striped bass (*Morone saxatilis*)
three spine stickleback (*Gasterosteus aculeatus*)
white barracudina (*Notolepis rissoi*)
white perch (*Morone americanus*)
windowpane flounder (*Scophthalmus aquosus*)
winter flounder (*Pseudopleuronectes americanus*)
winter skate (*Raja ocellata*)

crustaceans

grass shrimp
(*Hippolyte zostericola*)
green crab
(*Carcinus maenas*)
lady crab
(*Ovalipes ocellatus*)
mud crabs
(*Xanthidae sp.*)
rock crab
(*Cancer irroratus*)
sand shrimp
(*Crangon septemspinosa*)

Appendix 4. Protocols for Fish Identification Problems

What to do when ..... there are un-identifiable or un-known species

If you catch a species that you cannot identify, place one or two specimens in a zip-lock bag with a pencil-written label identifying date, site and your name. Transport the bag on ice and freeze until it can be identified by someone trained ion identification.

What to do when ..... there are identification problems due to fish size

There should be no confusion if you follow these guidelines:
Young of the year (YOY) are fish and crustaceran species that are newly hatched early in the sampling season, usually late June onwards. Most fish, other than tomcod, smelt and smooth flounder, spawn in summer so there are no YOY before mid-June. In the summer, the very tiny ones are the newly hatched YOY and are placed in the juvenile column. The guidelines for these are as follows: Mummichog $\leq$ 3 cm, silverside $\leq$ 8 cm, flounder $\leq$ 3 cm, sticklebacks in the $\leq$ 1.5 cm size.

Problems arise in September and October when YOY from the spring hatch have grown and become virtually indistinguishable from sexually mature conspecifics. When there is doubt they can be entered into the adult count, that is, use size as a determining factor. They may not yet be sexually mature yet, but volunteers are not expected to have to determine this.

A second problem arises when closely related species, which spawn at the same time, produce YOY that look virtually identical. Examples include: YOY of black spotted and 3-spine sticklebacks, YOY of banded killifish and mummichog and YOY of smooth flounder and winter flounder (though these last two do not spawn in the same place or time). When there is doubt about the identity of these YOY they are just identified to genus and recorded in the data sheet as YOY.

Appendix 5. List of Items Needed in the Field

Necessary Materials for Community Groups Going into Field

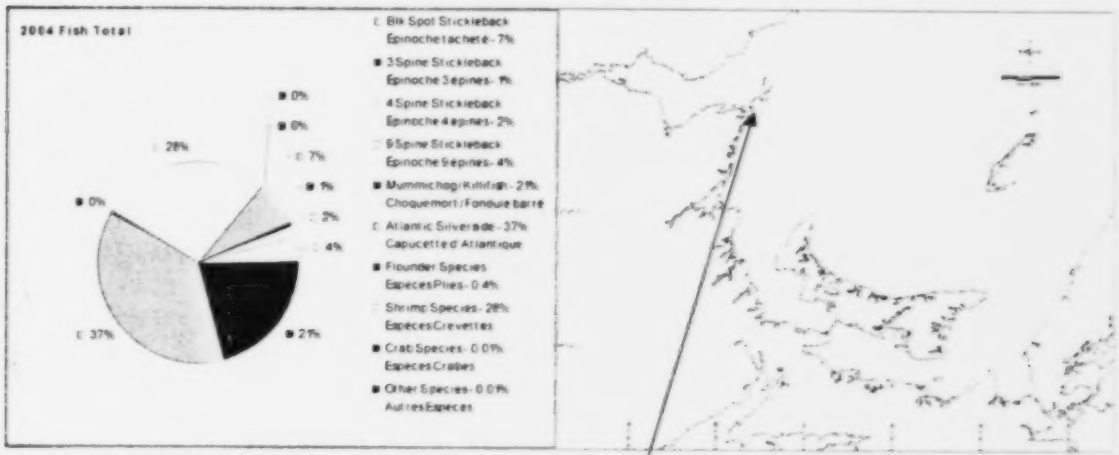
- Field Check List
  - 30 X 2 m, 6 mm mesh beach Seine
  - YSI temperature, salinity, oxygen meter in storage box
  - Distilled water (to wash YSI probe after final daily use)
  - Needle with attached twine (net repairs)
  - Quadrat
  - 20 X 20 cm fine mesh aquarium dip nets (3)
  - Underwater viewing box for assessing vegetation cover (Bucket with transparent bottom (pre-constructed)
  - Datasheets (rite in the rain waterproof paper for wet days)
  - Clip board with pencil on string and elastic to hold paper in wind
  - CAMP fish, crab, shrimp, algae Identification Guide
  - Guide Books (Peterson ID books)
  - Sampling Permit
  - Ziplock bags (for unidentified species and later for sediment)
  - Garden trowel
  - Small cooler (sample preservation)
  - first aid kit
  - floating safety rope and ring if avaialble

- Personal Check List
  - Hat
  - Sunscreen
  - Sunglasses (polarized)
  - Chest/Leg Waders or Waterproof Boots
  - Insect Repellent
  - Lunch/Snacks (for at least 4 -5hours)
  - Lots of liquid (water for hot days)
  - Warm apparel (for colder days)
  - cell phone

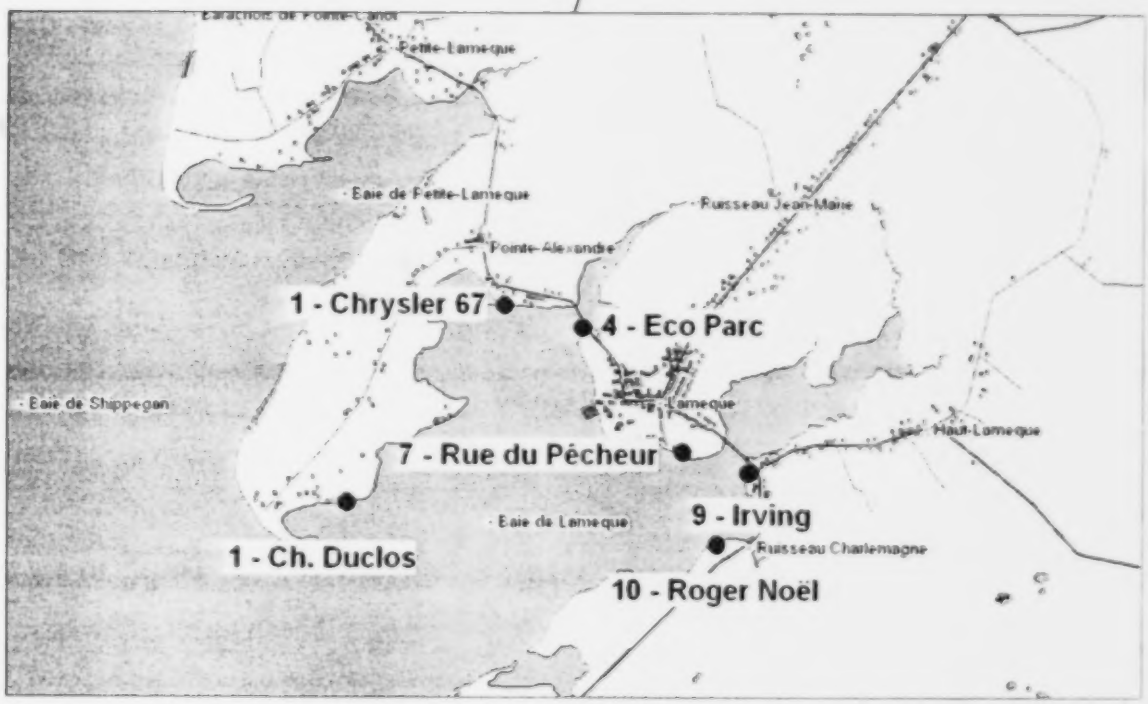
Appendix 6. Methodology for Sediment Sample Analysis

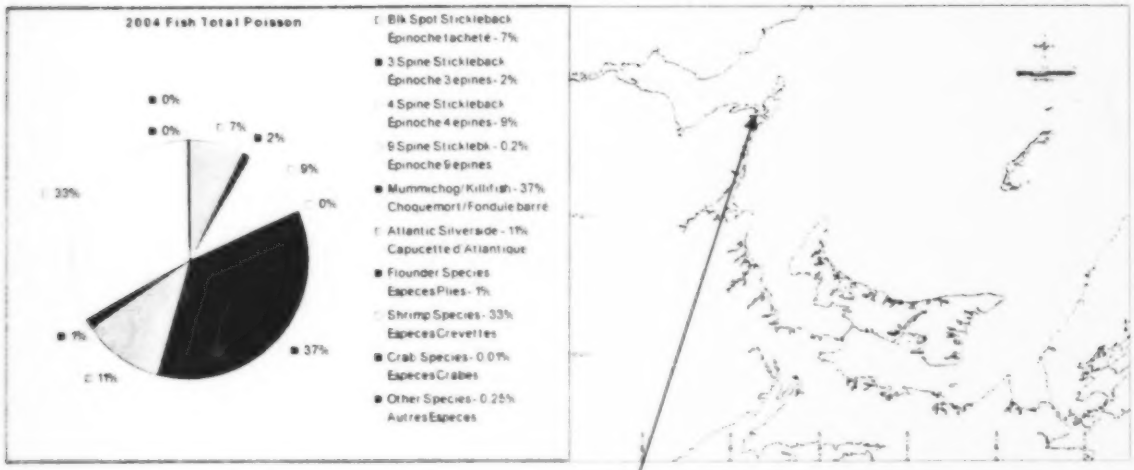
1. Surficial sediment (top 5-10cm) samples were collected at arm's length depth within the beach-seined area using a garden trowel and placing the sample in a labelled plastic bag.
2. All samples were frozen at DFO headquarters in Moncton for analysis during the winter.
3. The sediment samples were removed from the freezer and allowed to thaw for 4-5 hours.
4. A sub-sample (100-150 gram) was placed in a pre-weighed (nearest 0.01 g) aluminum dish. The dish should be three-quarters to five-sixths full.
5. The wet mass of sample and dish was determined.
6. The sediment sample was put in an oven at 70° C for at least 24 hours.
7. The dish was removed and the dry mass determined and recorded to 2 decimal place accuracy. Loss of mass represents the percent moisture.
8. This sample was then placed in a muffle oven and cooked for 3 hours at 500°C. This completely removes all organic content in the sample.
9. A second measure of mass was made and the difference from the dry sample represents the total organic content.
10. Put the remaining ash sediment through a series of sieves for size fractionating to determine sediment type and mass of individual size proportions.
11. This sample of dry sediment was shaken for 10 minutes.
12. Sediment sizes are fractioned into sand (2mm – 1mm - >500µm) medium sand (>250µm) fine sand (>125µm) very fine sand (>63µm) and silt (<63µm).
13. After separation the masses of these 5 sediment sizes were determined.
14. Finally, a mean grain size was determined that reflects the dominant size in the sample.
15. Sediment mass fractions (calculated in percent of the total sample mass) were transformed into a cumulative frequency series and plotted as a cumulative frequency curve. From the resulting graph, the mean grain size (D50) was determined. The D50 represents the median grain size at which 50 percent of the sample is dominant.

Appendix 7. Map of each Estuary/Coastal Shoreline Location Showing Sampling Sites plus a Pie Chart that Summarizes the Total Quantities of the Most Abundant Species for the 2004 Sampling Season

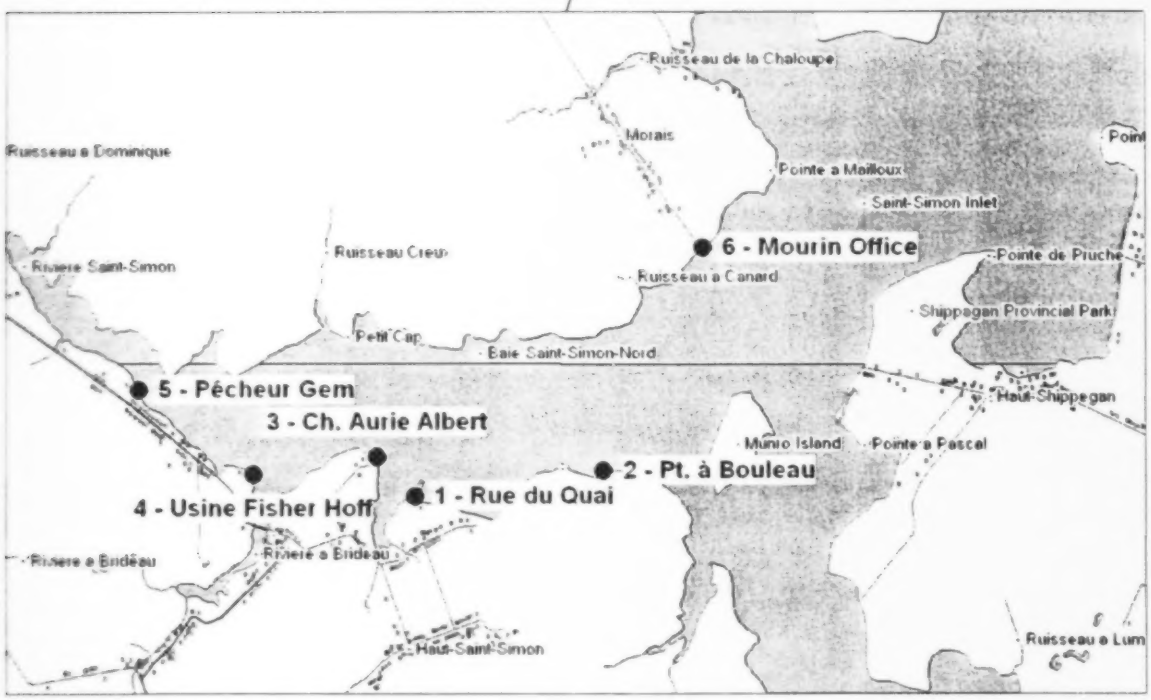


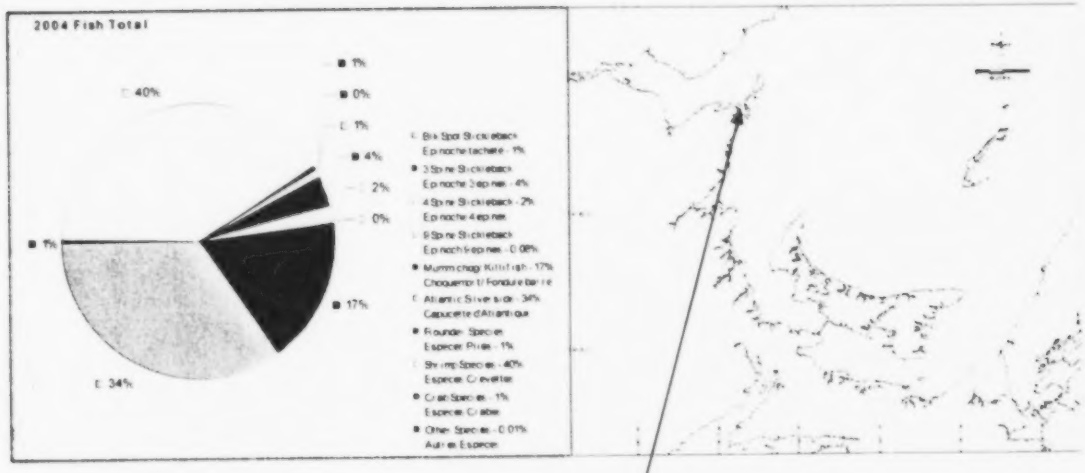
New Brunswick / Lamèque



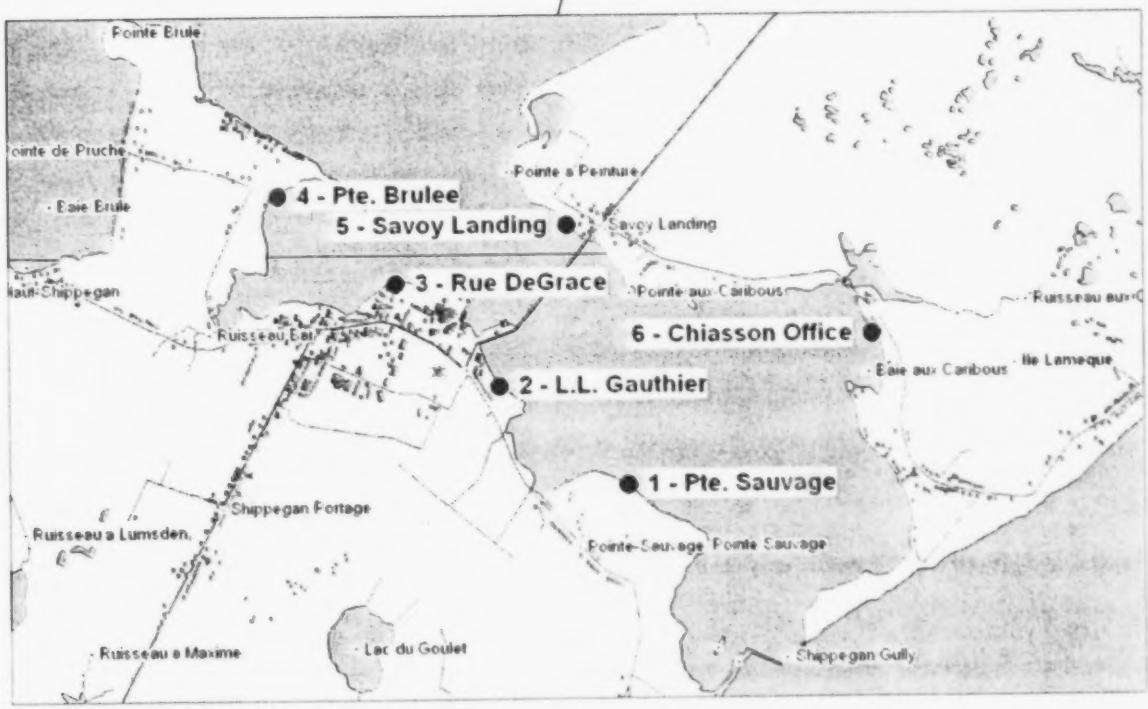


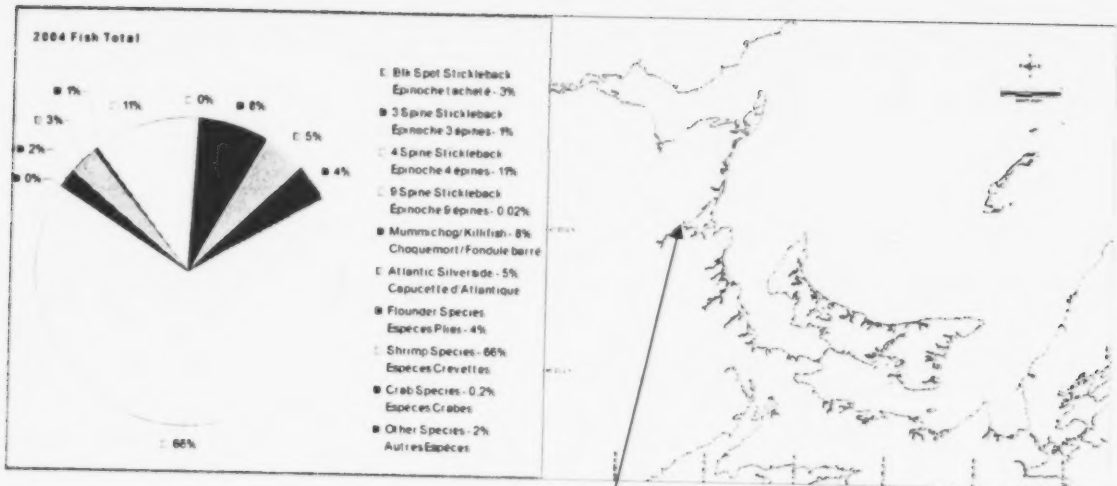
New Brunswick / St. Simon



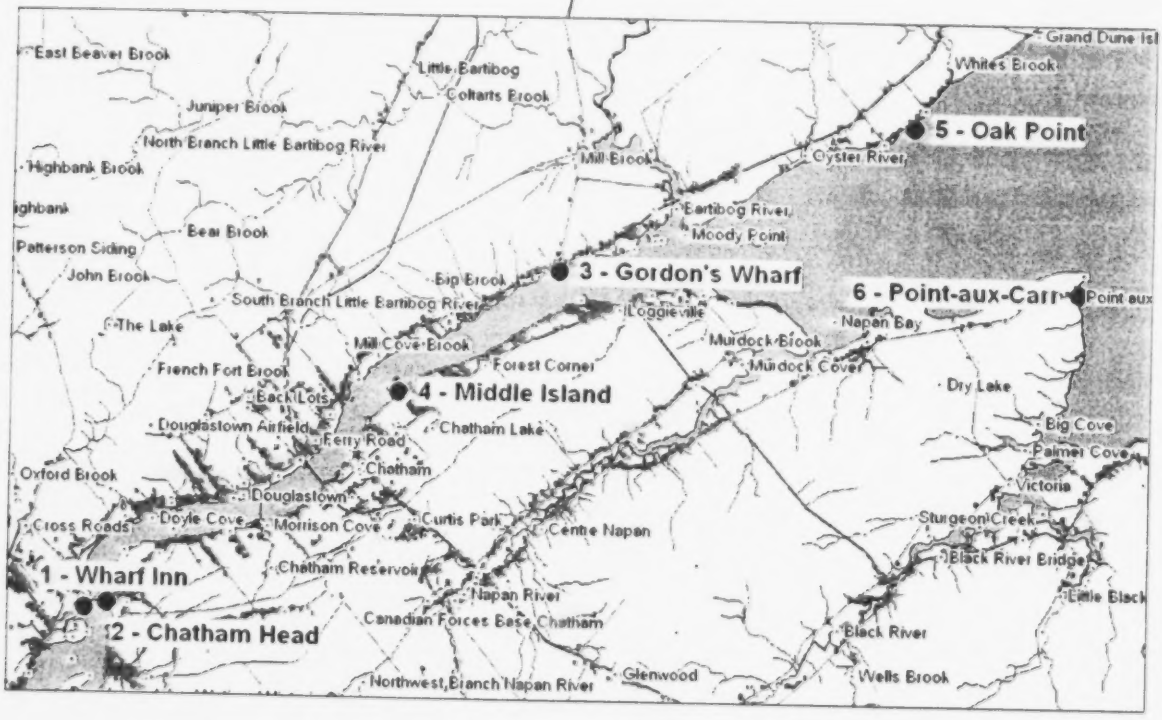


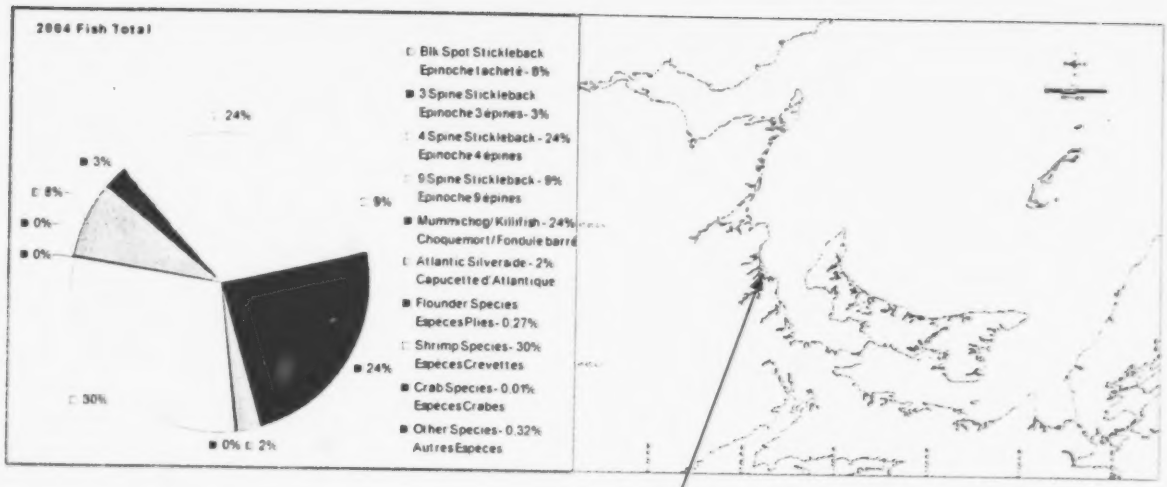
New Brunswick / Shippagan



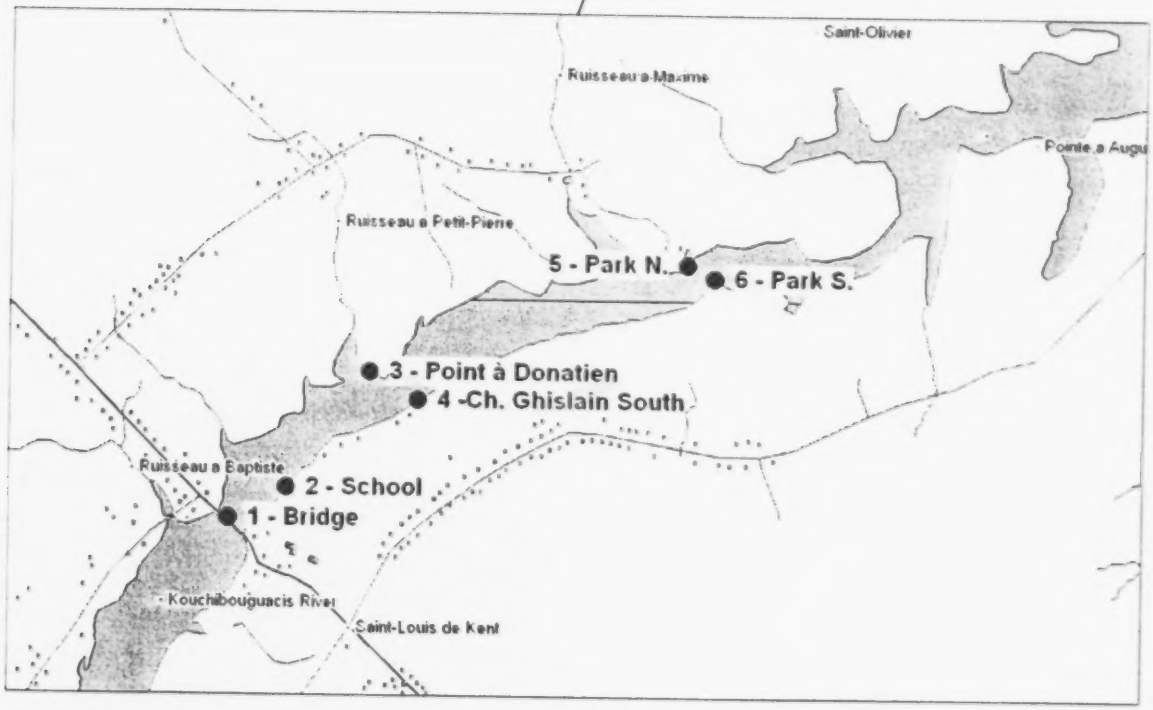


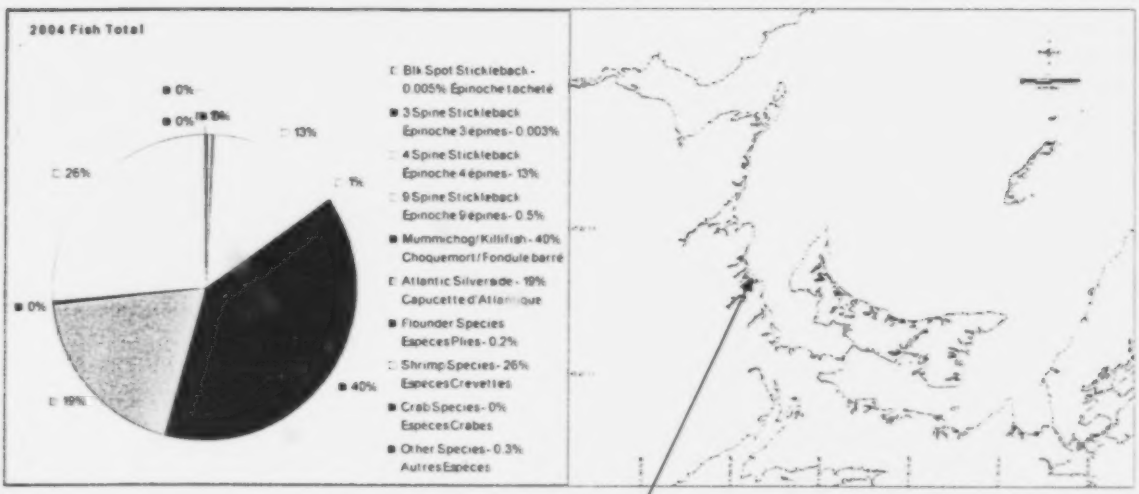
New Brunswick / Miramichi



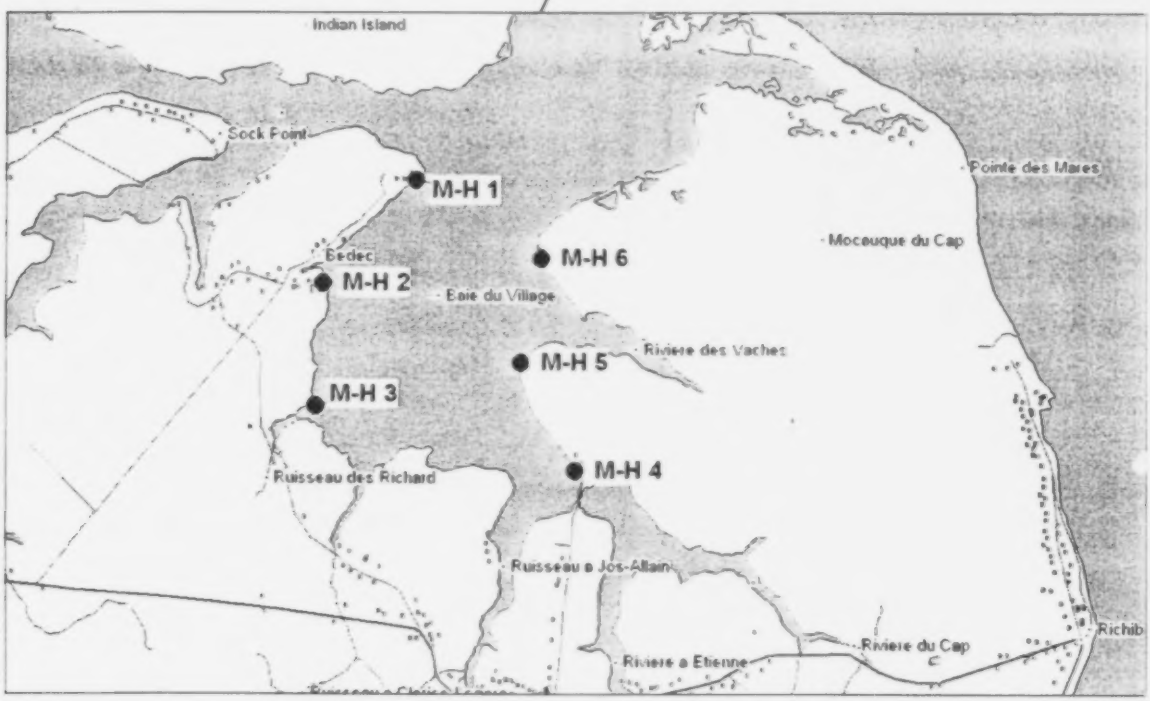


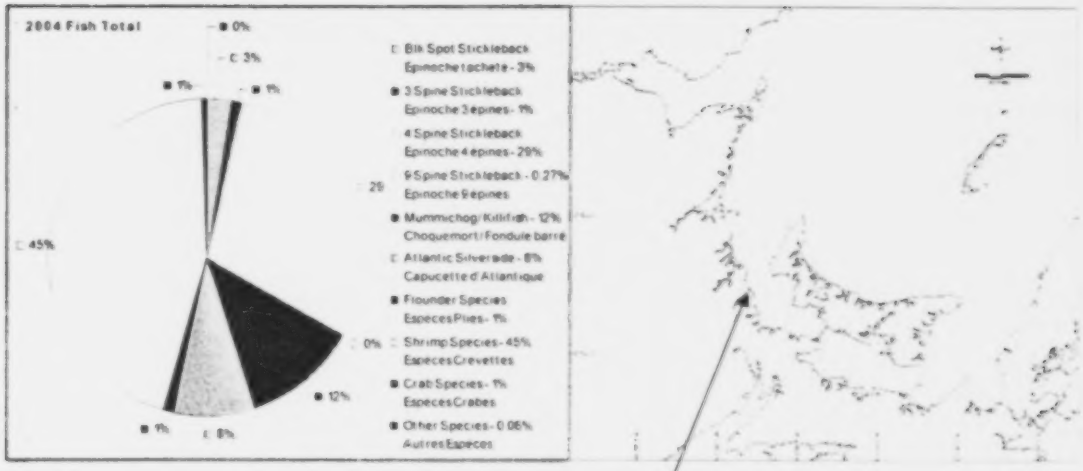
New Brunswick / St. Louis de Kent



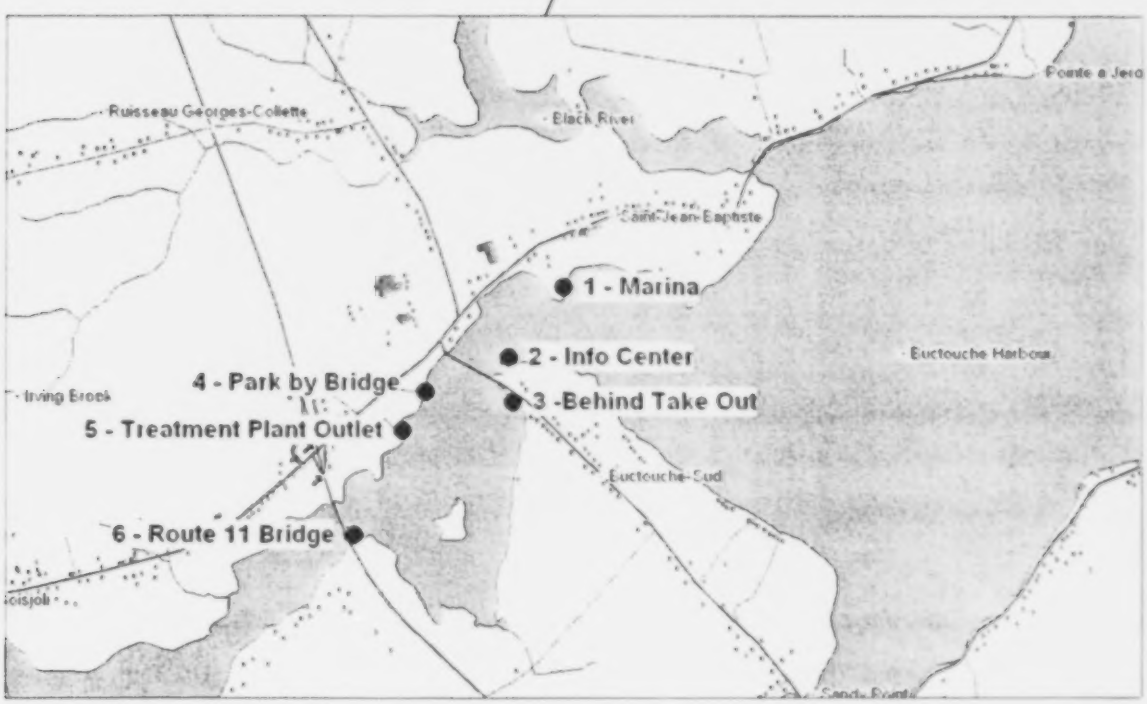

2004 Fish Total
0%
0%
13%
26%
1%
0%
40%
19%
Blk Spot Stickleback - 0.005% Épinoche tachetée
3 Spine Stickleback Épinoche 3 épines - 0.003%
4 Spine Stickleback Épinoche 4 épines - 13%
9 Spine Stickleback Épinoche 9 épines - 0.5%
Mummichog/Killifish - 40% Choquemort/Fondule barré
Atlantic Silverside - 19% Capucette d'Atlantique
Flounder Species Especes Plies - 0.2%
Shrimp Species - 26% Especes Crevettes
Crab Species - 0% Especes Crabes
Other Species - 0.3% Autres Especes

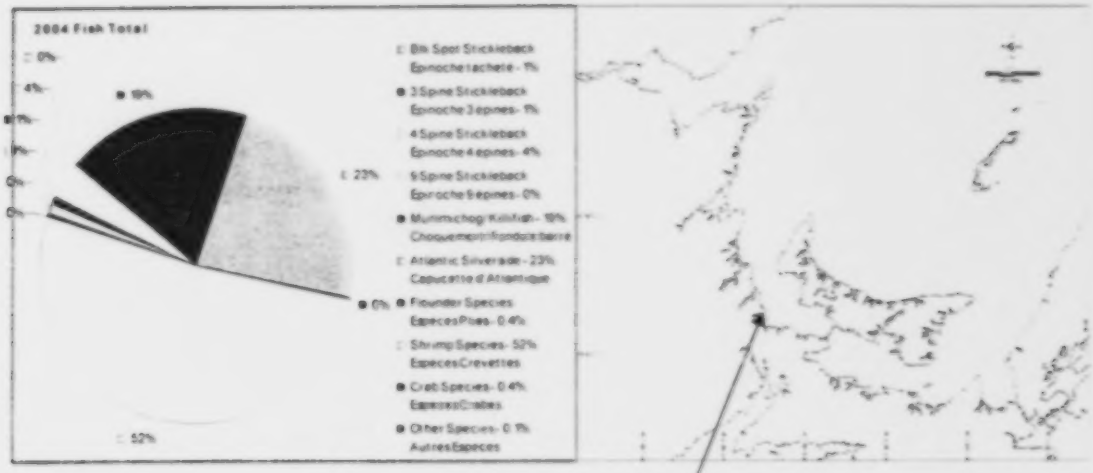
New Brunswick / Baie de Village



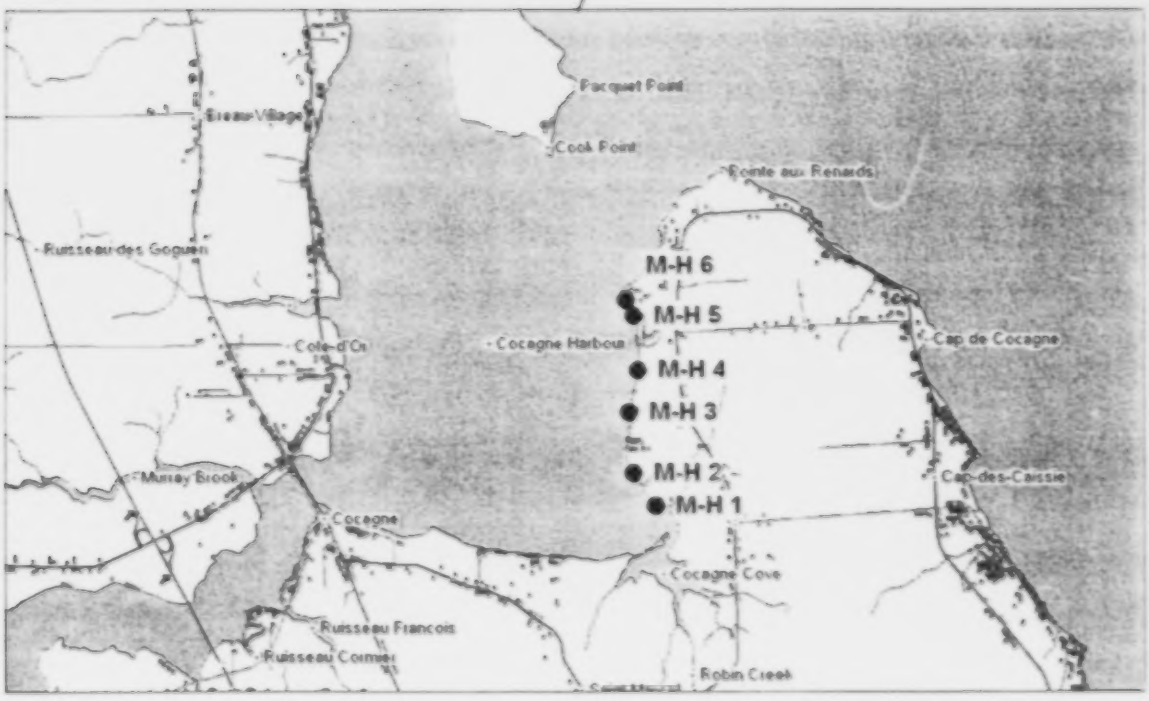


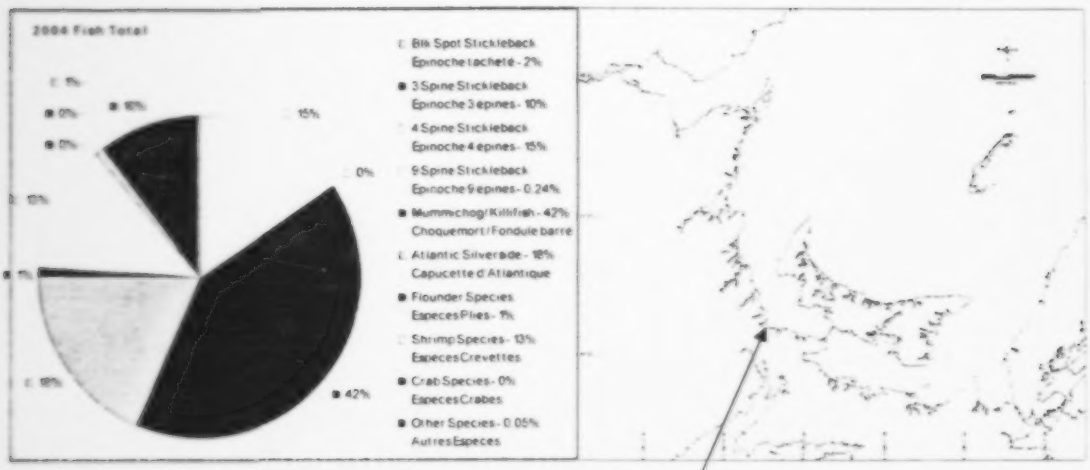
New Brunswick / Bouctouche



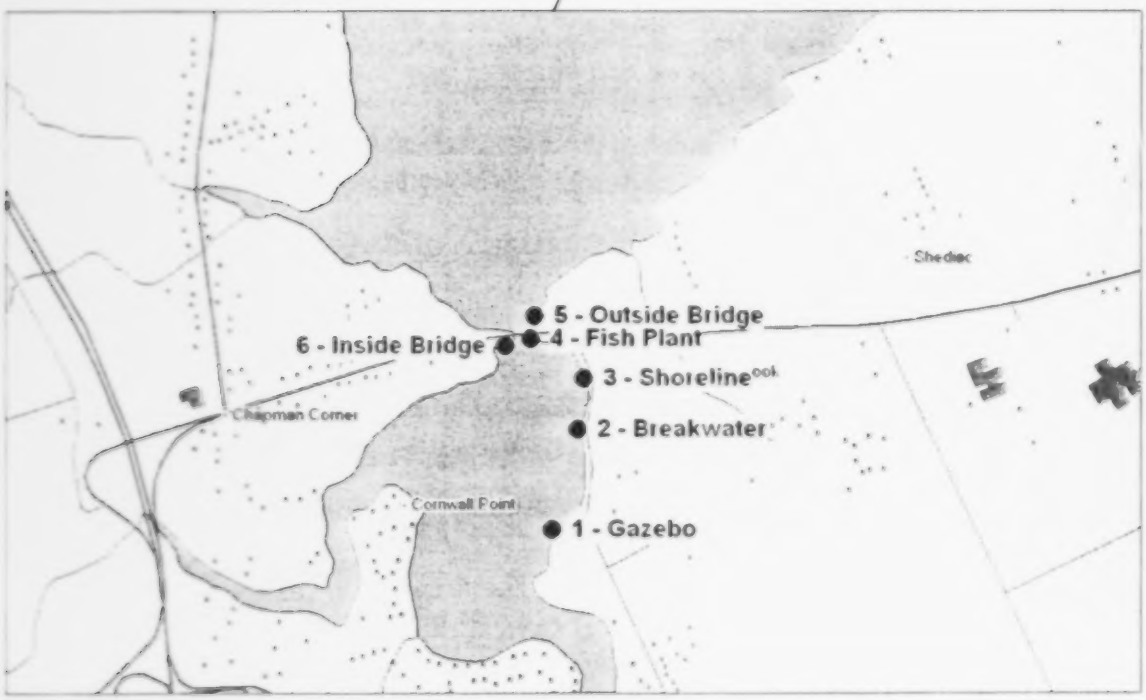


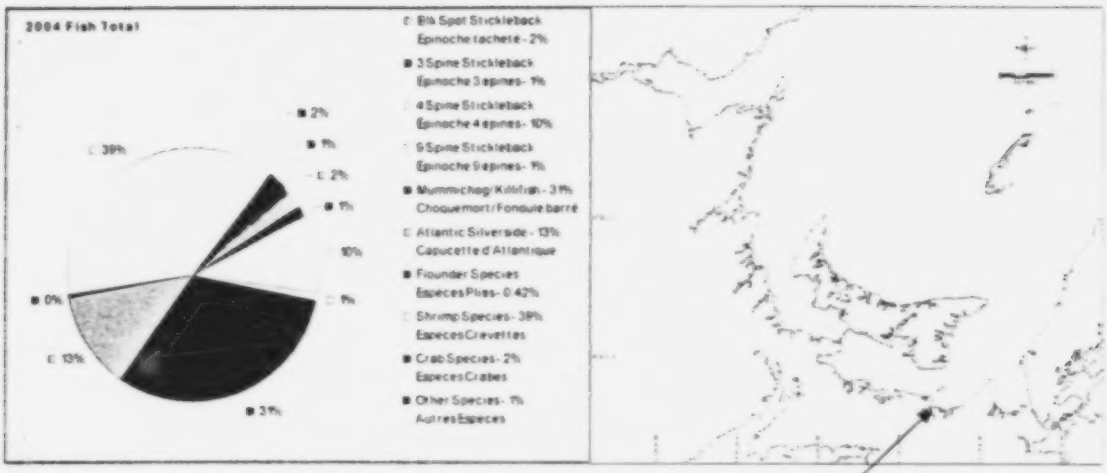
New Brunswick / Cocagne



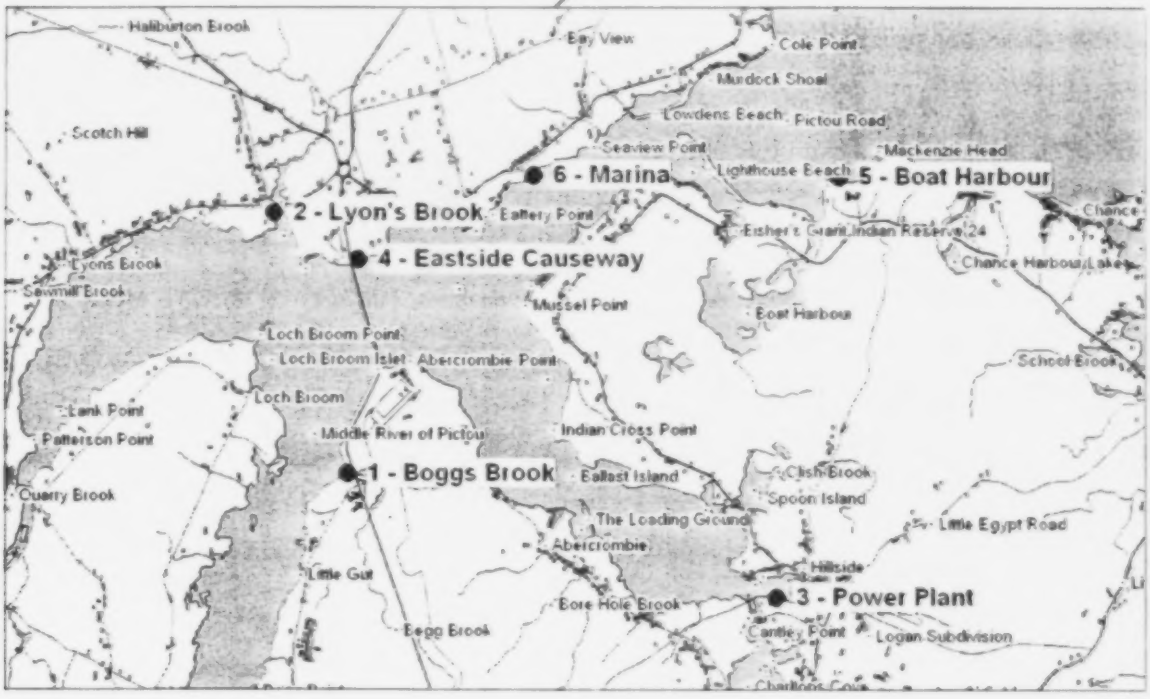


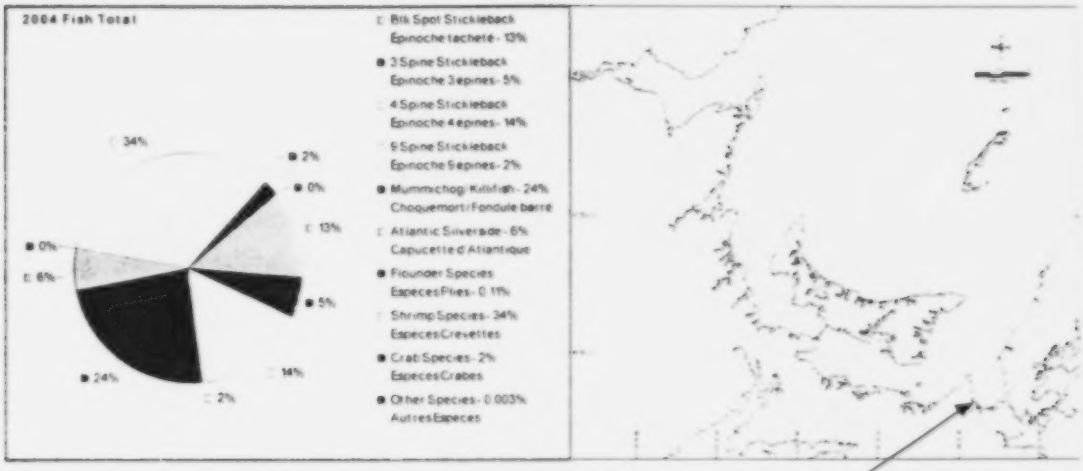
New Brunswick / Shediac



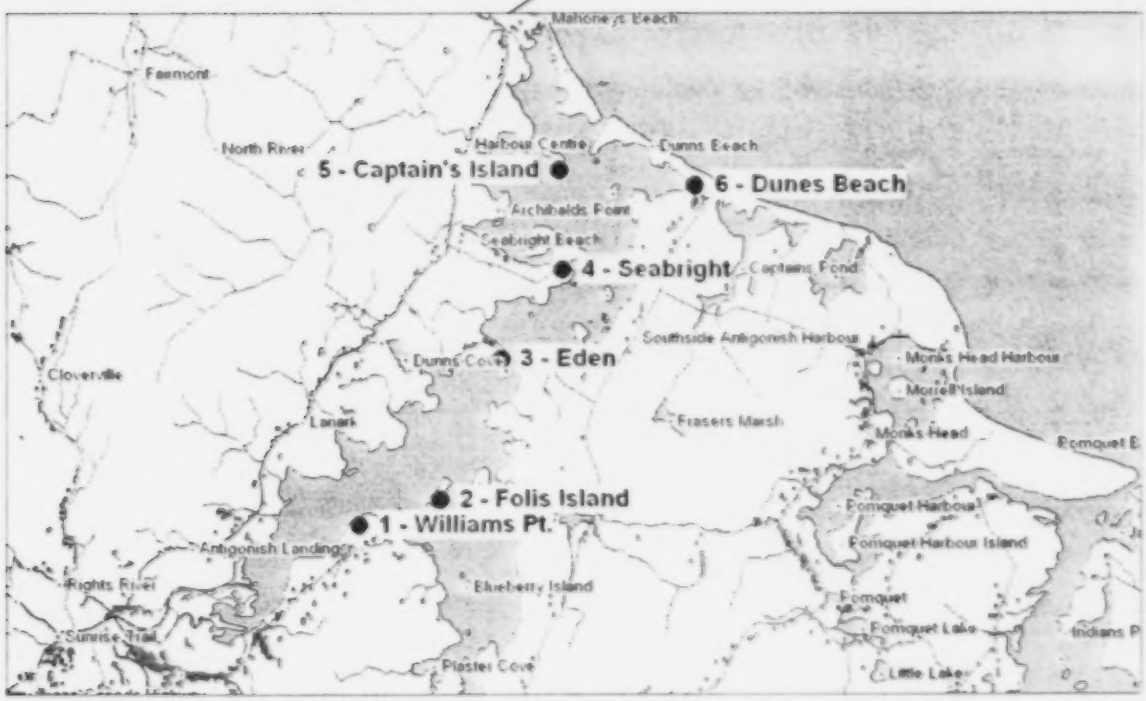


Nova Scotia / Pictou





Nova Scotia / Antigonish



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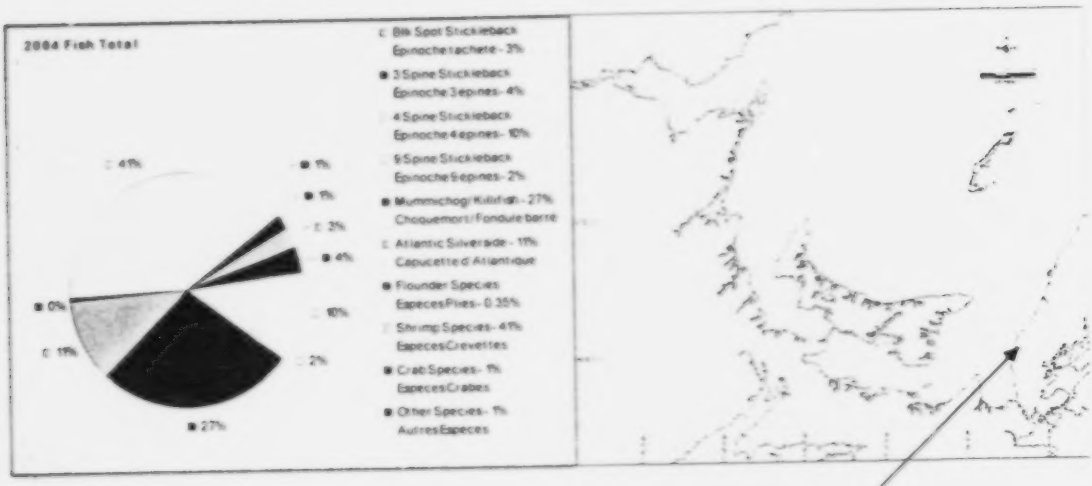
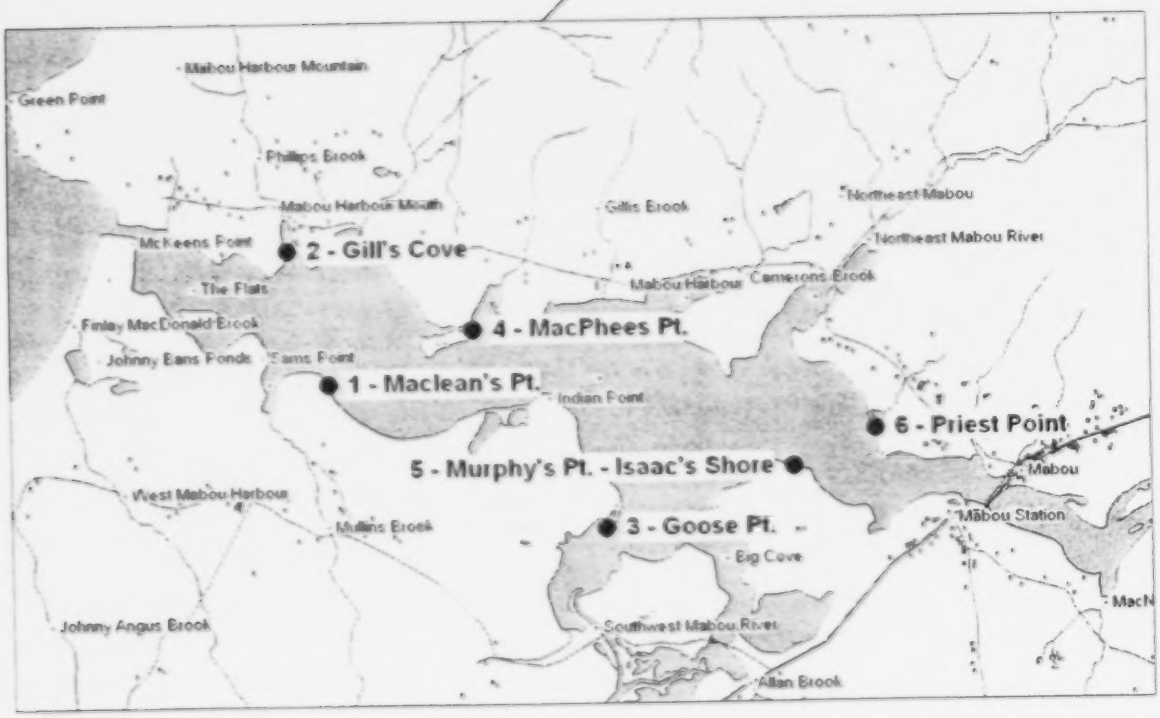
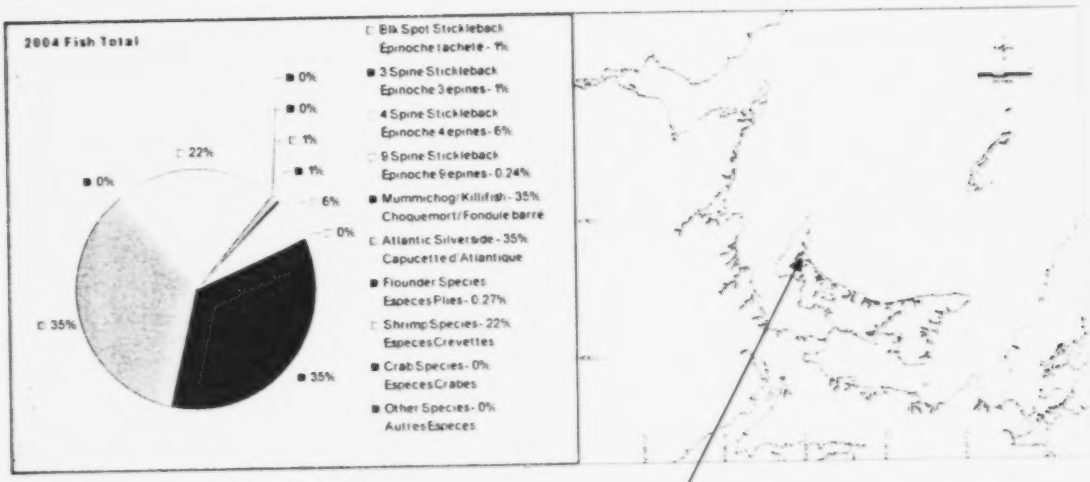
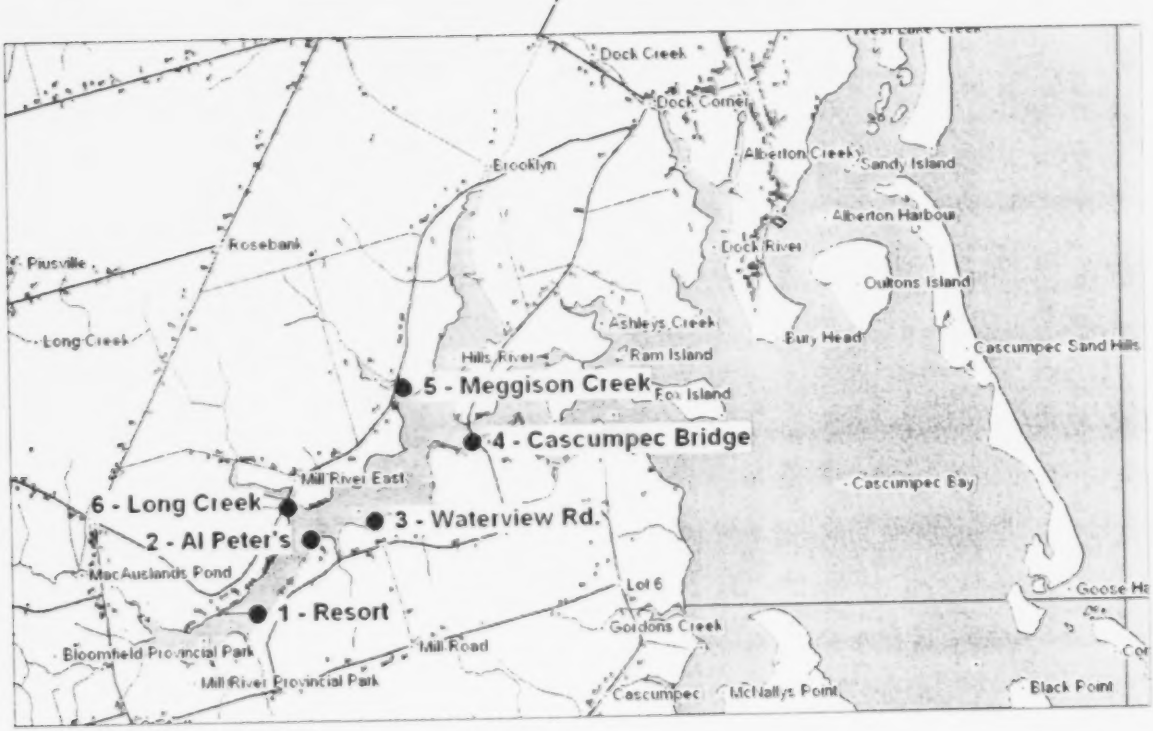


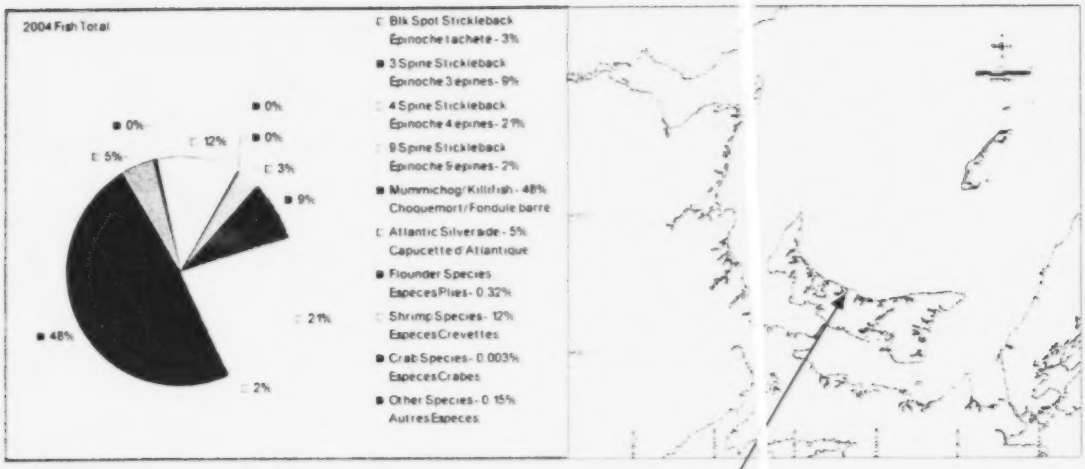
Nova Scotia / Mabou



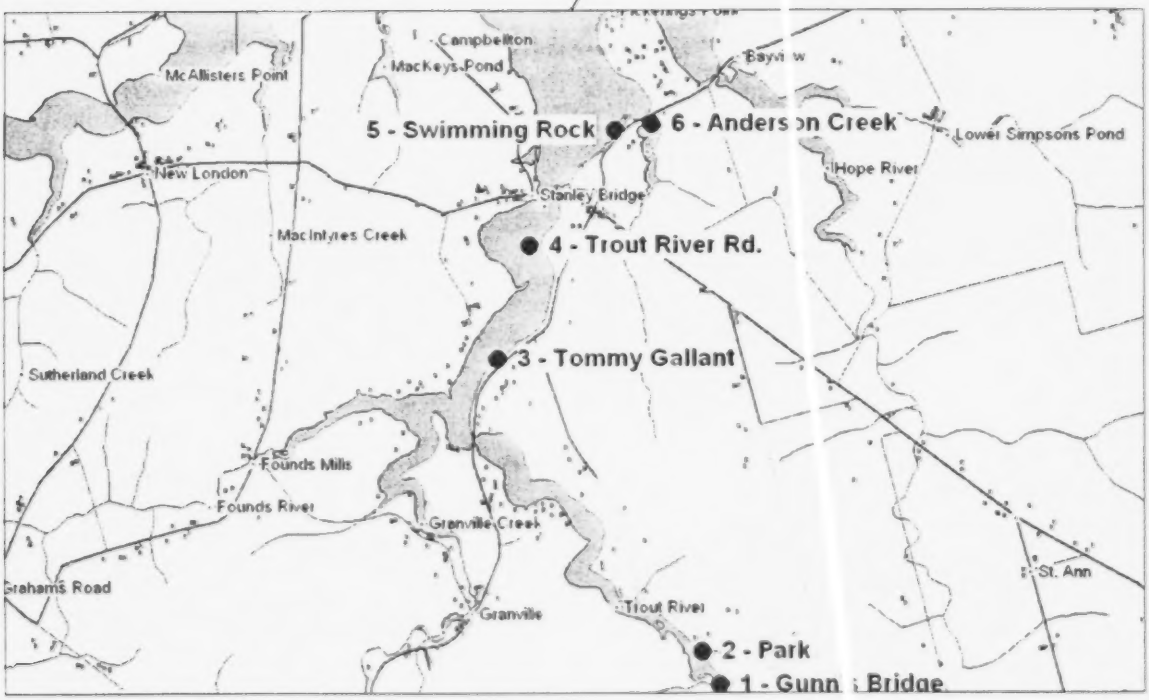


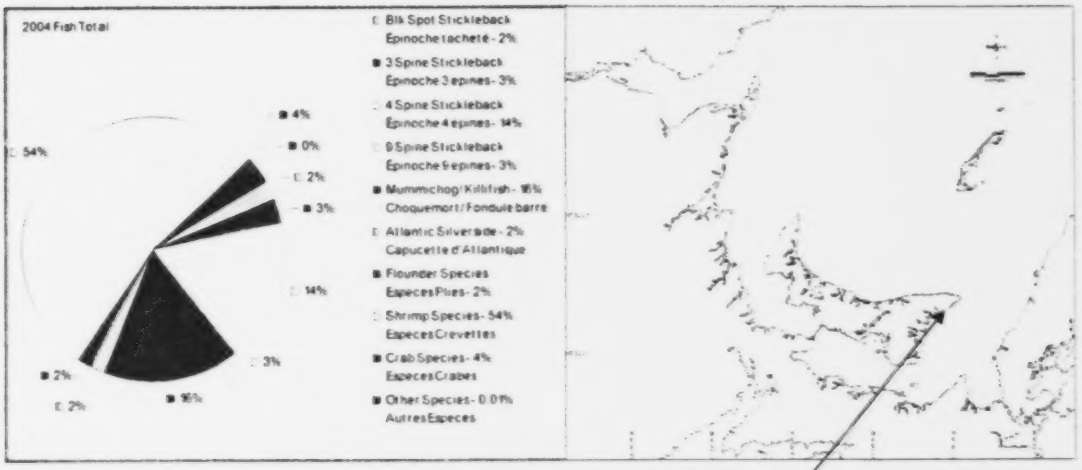
Prince Edward Island / Mill River





Prince Edward Island / Trout River





Prince Edward Island / Basin Head